FIG.1

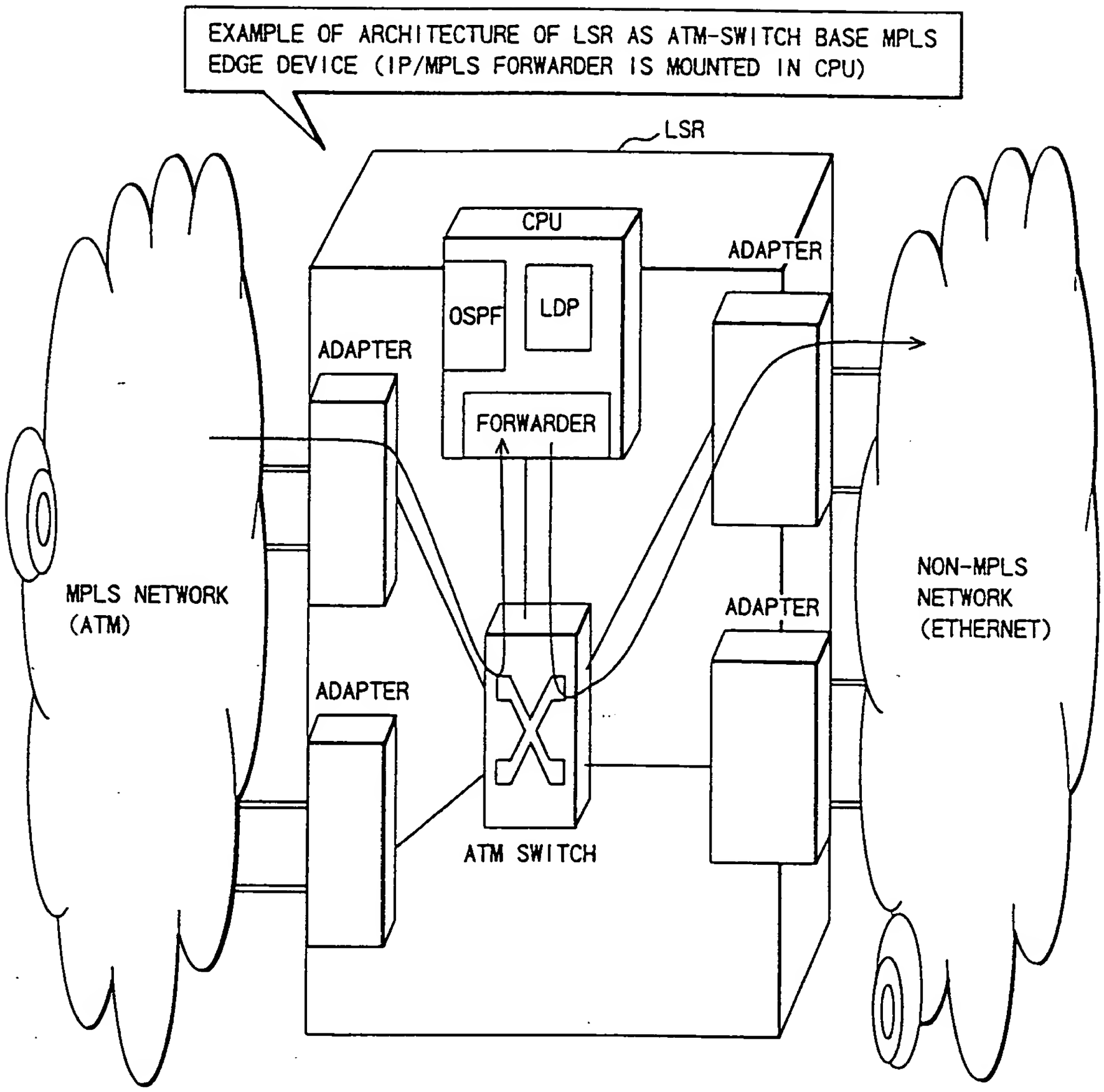

EXAMPLE OF ARCHITECTURE OF LSR AS ATM-SWITCH BASE MPLS EDGE DEVICE (IP/MPLS FORWARDER IS MOUNTED IN CPU)
LSR
CPU
OSPF
LDP
FORWARDER
ADAPTER
ADAPTER
ADAPTER
ADAPTER
MPLS NETWORK (ATM)
ATM SWITCH
NON-MPLS NETWORK (ETHERNET)

FIG.2

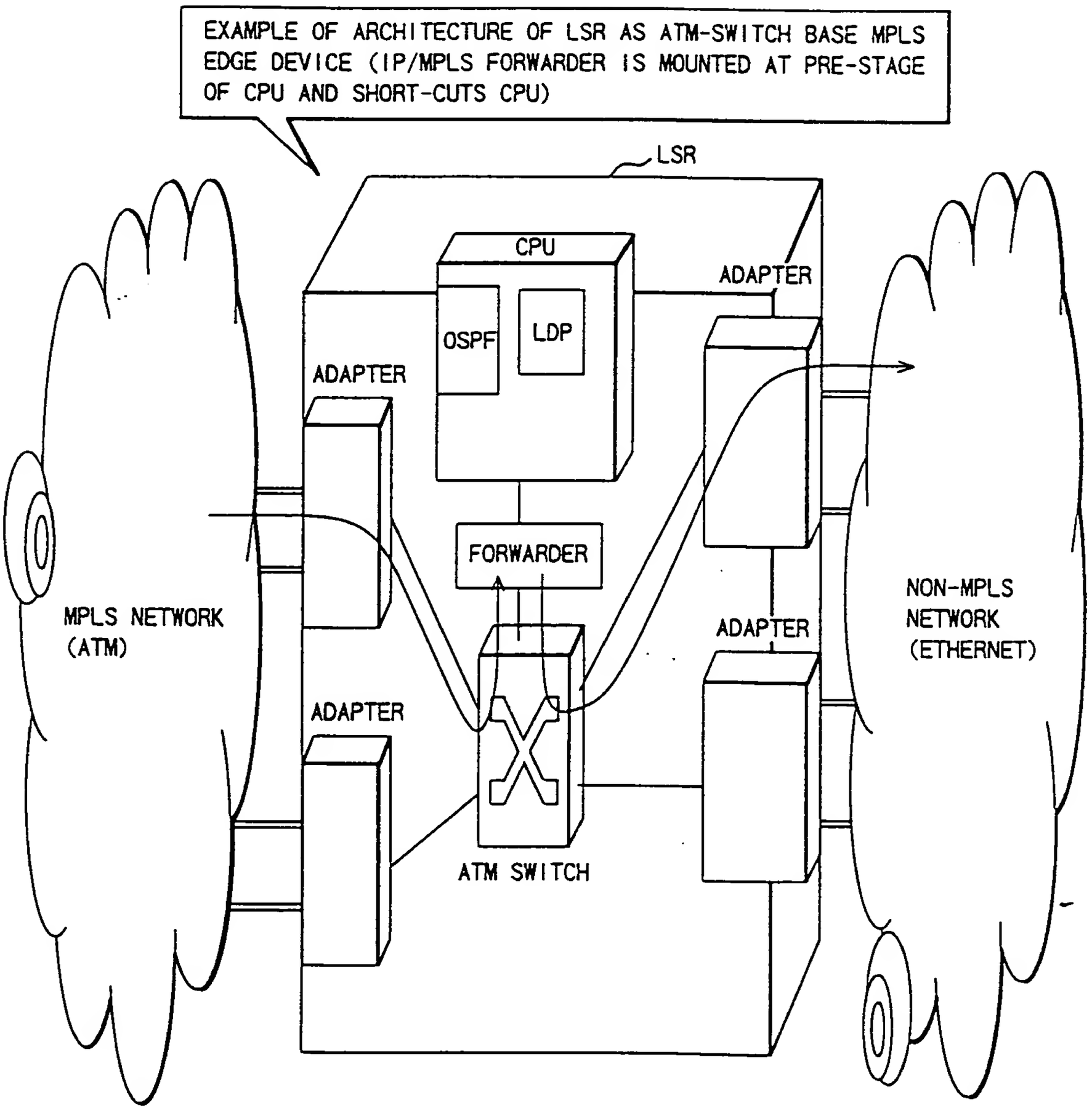

EXAMPLE OF ARCHITECTURE OF LSR AS ATM-SWITCH BASE MPLS EDGE DEVICE (IP/MPLS FORWARDER IS MOUNTED AT PRE-STAGE OF CPU AND SHORT-CUTS CPU)
LSR
CPU
OSPF
LDP
ADAPTER
ADAPTER
ADAPTER
ADAPTER
ADAPTER
FORWARDER
MPLS NETWORK
(ATM)
NON-MPLS
NETWORK
(ETHERNET)
ATM SWITCH

FIG.3

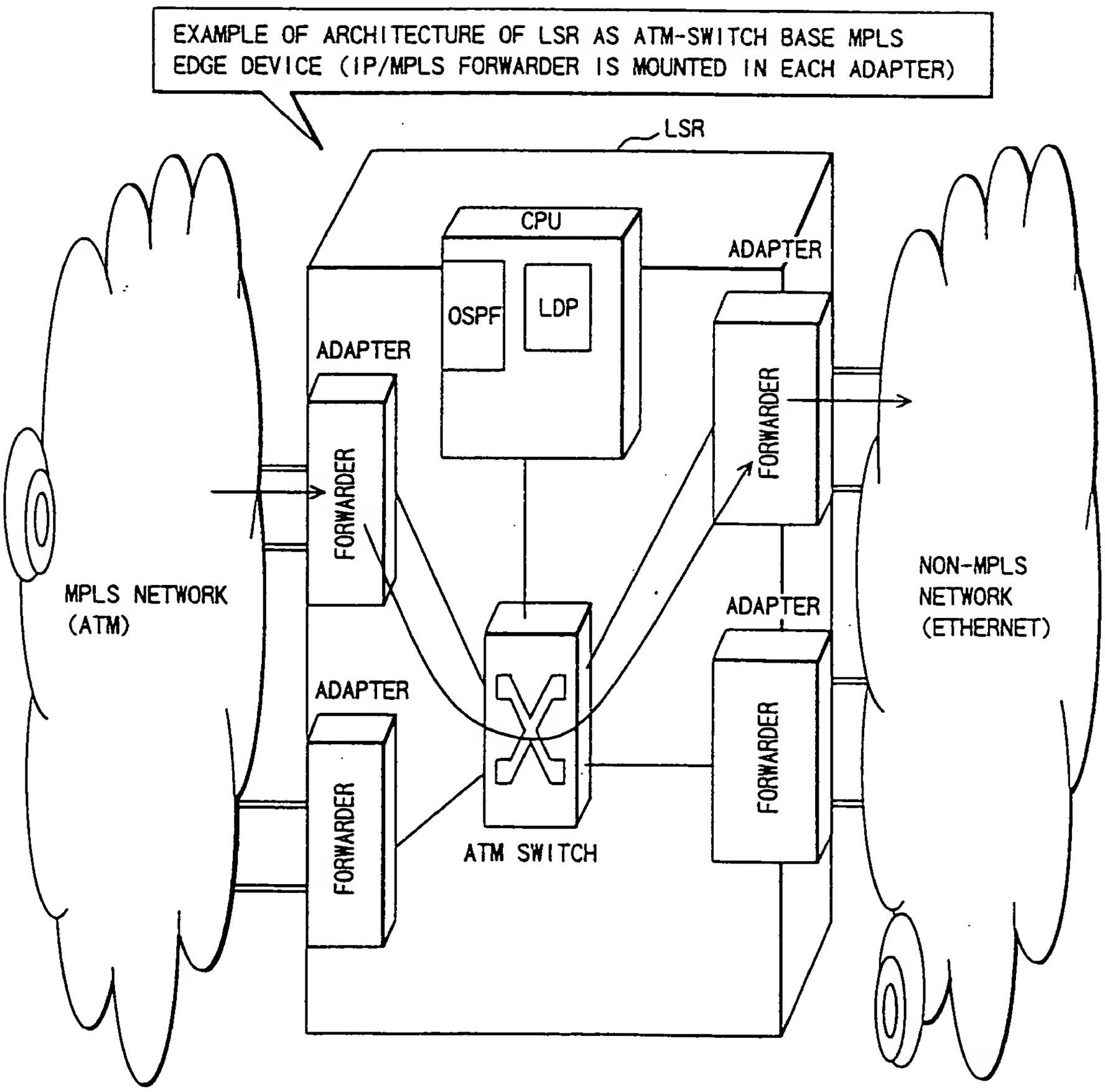

EXAMPLE OF ARCHITECTURE OF LSR AS ATM-SWITCH BASE MPLS EDGE DEVICE (IP/MPLS FORWARDER IS MOUNTED IN EACH ADAPTER)
LSR
CPU
OSPF
LDP
ADAPTER
ADAPTER
ADAPTER
ADAPTER
FORWARDER
FORWARDER
FORWARDER
FORWARDER
MPLS NETWORK (ATM)
NON-MPLS NETWORK (ETHERNET)
ATM SWITCH

FIG.4

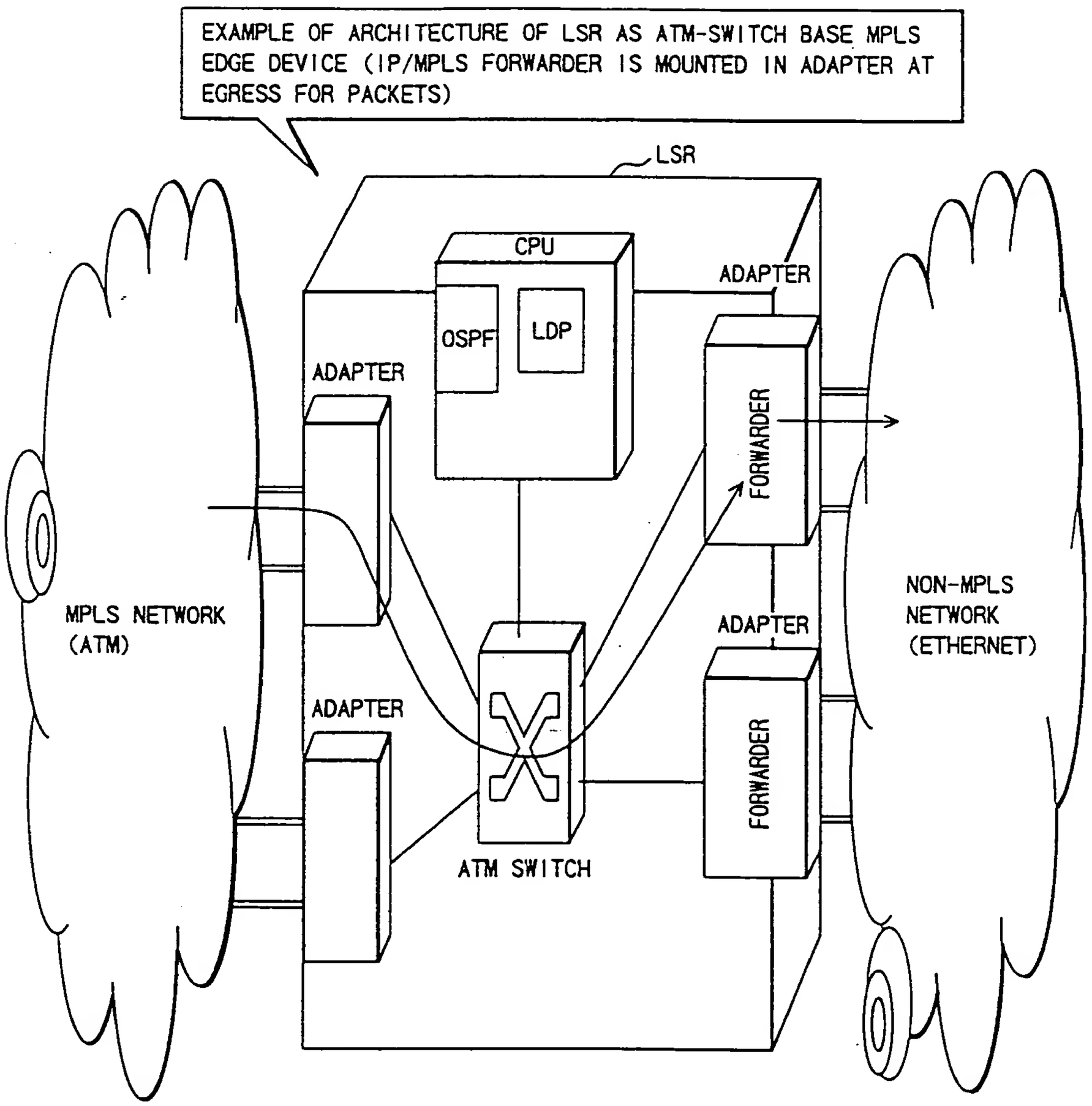

EXAMPLE OF ARCHITECTURE OF LSR AS ATM-SWITCH BASE MPLS EDGE DEVICE (IP/MPLS FORWARDER IS MOUNTED IN ADAPTER AT EGRESS FOR PACKETS)
LSR
CPU
OSPF
LDP
ADAPTER
ADAPTER
ADAPTER
ADAPTER
FORWARDER
FORWARDER
MPLS NETWORK (ATM)
NON-MPLS NETWORK (ETHERNET)
ATM SWITCH

FIG.5

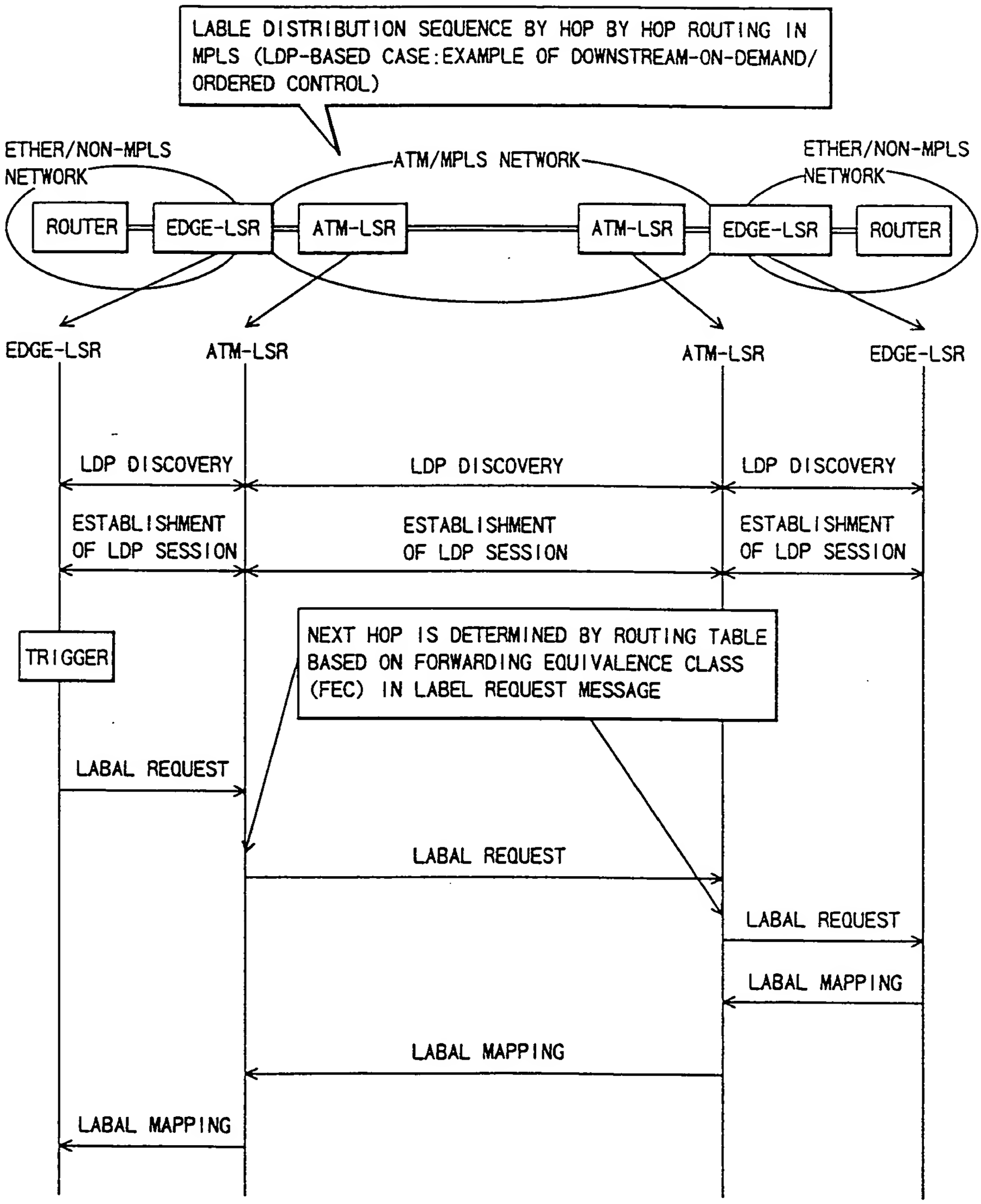

LABLE DISTRIBUTION SEQUENCE BY HOP BY HOP ROUTING IN MPLS (LDP-BASED CASE:EXAMPLE OF DOWNSTREAM-ON-DEMAND/ ORDERED CONTROL)
ETHER/NON-MPLS NETWORK
ATM/MPLS NETWORK
ETHER/NON-MPLS NETWORK
ROUTER
EDGE-LSR
ATM-LSR
ATM-LSR
EDGE-LSR
ROUTER
EDGE-LSR
ATM-LSR
ATM-LSR
EDGE-LSR
LDP DISCOVERY
LDP DISCOVERY
LDP DISCOVERY
ESTABLISHMENT OF LDP SESSION
ESTABLISHMENT OF LDP SESSION
ESTABLISHMENT OF LDP SESSION
TRIGGER
NEXT HOP IS DETERMINED BY ROUTING TABLE BASED ON FORWARDING EQUIVALENCE CLASS (FEC) IN LABEL REQUEST MESSAGE
LABAL REQUEST
LABAL REQUEST
LABAL REQUEST
LABAL MAPPING
LABAL MAPPING
LABAL MAPPING

FIG.6

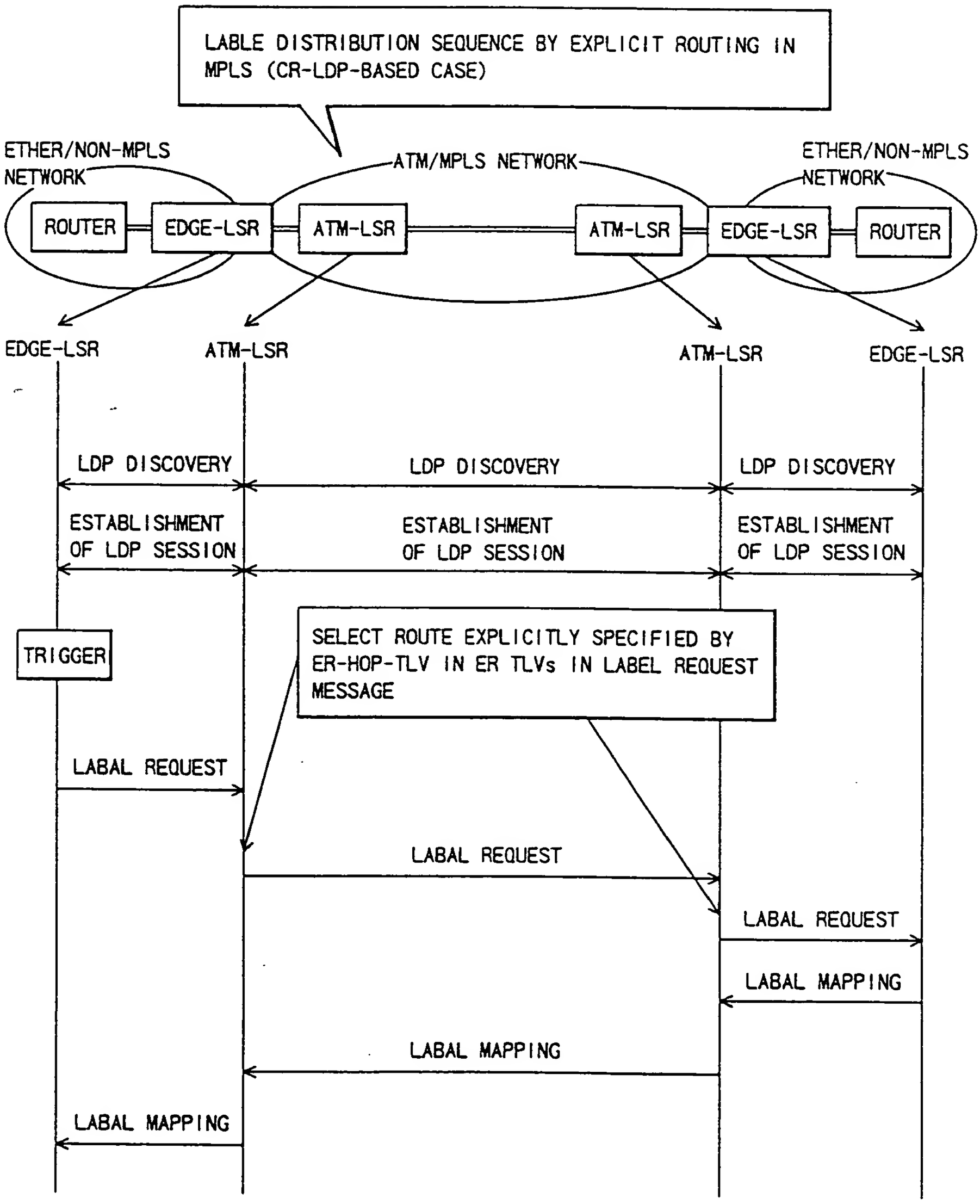

LABLE DISTRIBUTION SEQUENCE BY EXPLICIT ROUTING IN MPLS (CR-LDP-BASED CASE)
ETHER/NON-MPLS NETWORK
ATM/MPLS NETWORK
ETHER/NON-MPLS NETWORK
ROUTER
EDGE-LSR
ATM-LSR
ATM-LSR
EDGE-LSR
ROUTER
EDGE-LSR
ATM-LSR
ATM-LSR
EDGE-LSR
LDP DISCOVERY
LDP DISCOVERY
LDP DISCOVERY
ESTABLISHMENT OF LDP SESSION
ESTABLISHMENT OF LDP SESSION
ESTABLISHMENT OF LDP SESSION
TRIGGER
SELECT ROUTE EXPLICITLY SPECIFIED BY ER-HOP-TLV IN ER TLVs IN LABEL REQUEST MESSAGE
LABAL REQUEST
LABAL REQUEST
LABAL REQUEST
LABAL MAPPING
LABAL MAPPING
LABAL MAPPING

FIG.7

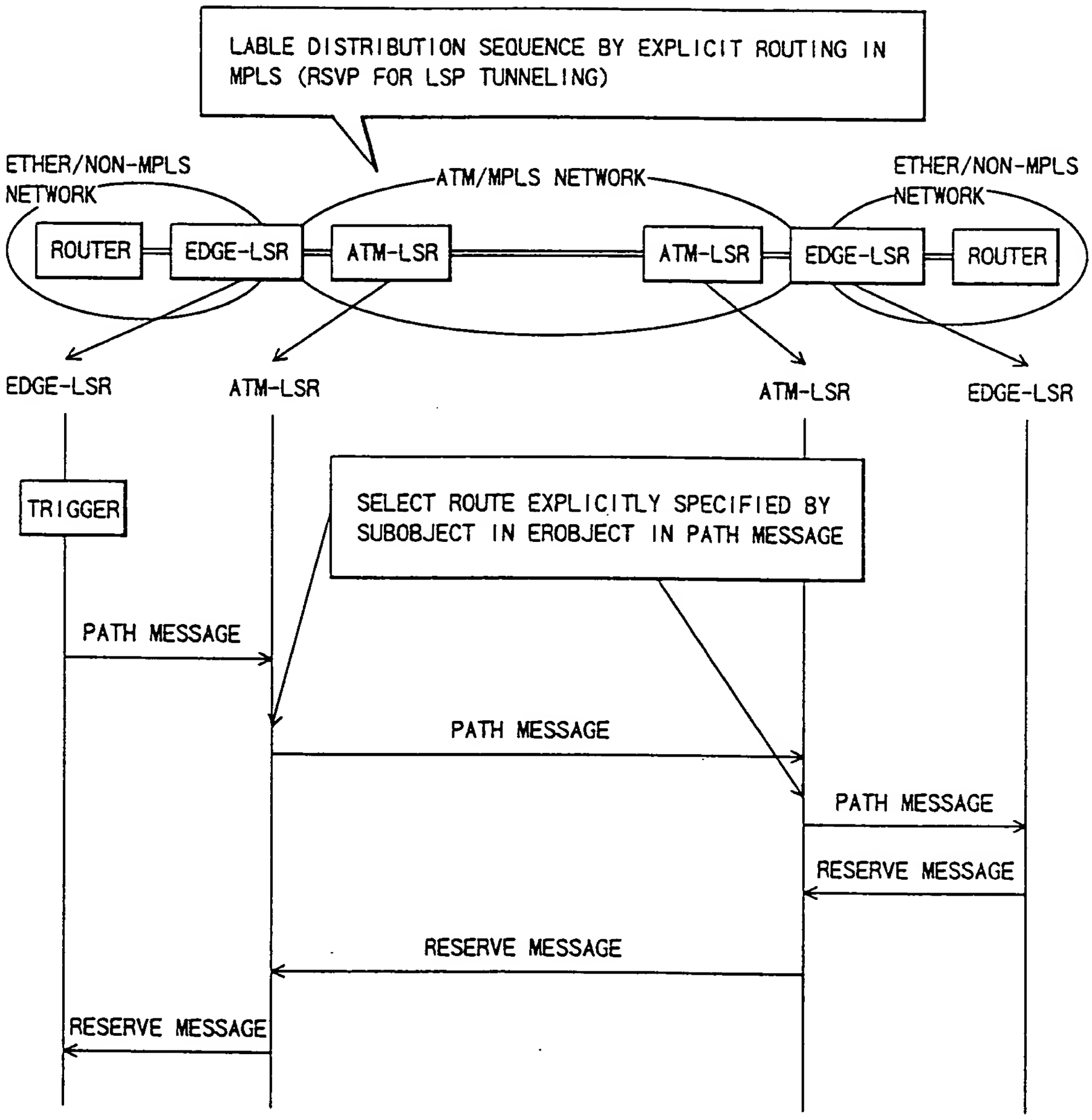

LABLE DISTRIBUTION SEQUENCE BY EXPLICIT ROUTING IN MPLS (RSVP FOR LSP TUNNELING)
ETHER/NON-MPLS NETWORK
ATM/MPLS NETWORK
ETHER/NON-MPLS NETWORK
ROUTER
EDGE-LSR
ATM-LSR
ATM-LSR
EDGE-LSR
ROUTER
EDGE-LSR
ATM-LSR
ATM-LSR
EDGE-LSR
TRIGGER
SELECT ROUTE EXPLICITLY SPECIFIED BY SUBOBJECT IN EROBJECT IN PATH MESSAGE
PATH MESSAGE
PATH MESSAGE
PATH MESSAGE
RESERVE MESSAGE
RESERVE MESSAGE
RESERVE MESSAGE

FIG.8

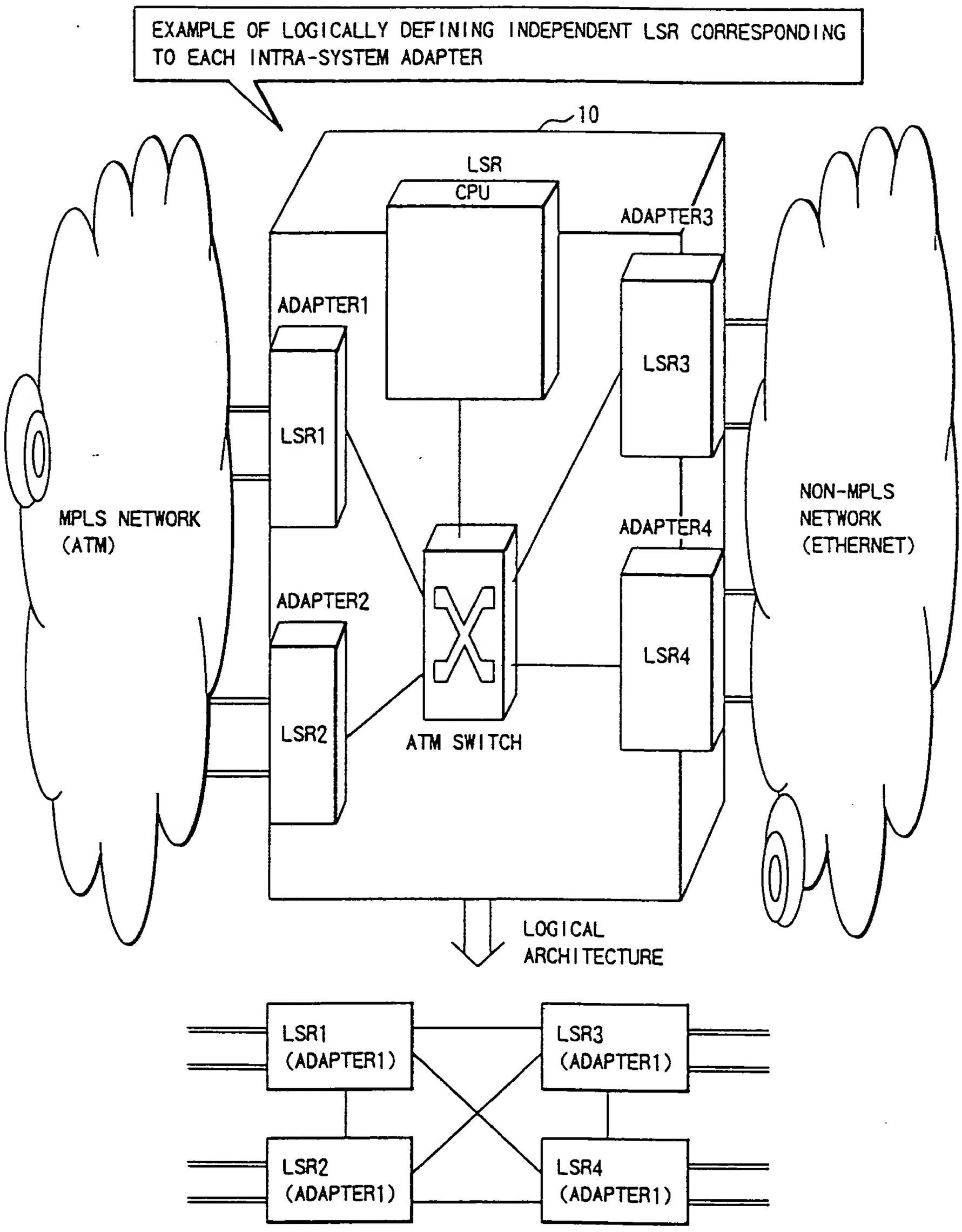

EXAMPLE OF LOGICALLY DEFINING INDEPENDENT LSR CORRESPONDING TO EACH INTRA-SYSTEM ADAPTER
10
LSR
CPU
ADAPTER1
ADAPTER2
ADAPTER3
ADAPTER4
LSR1
LSR2
LSR3
LSR4
MPLS NETWORK (ATM)
NON-MPLS NETWORK (ETHERNET)
ATM SWITCH
LOGICAL ARCHITECTURE
LSR1 (ADAPTER1)
LSR2 (ADAPTER1)
LSR3 (ADAPTER1)
LSR4 (ADAPTER1)

FIG.9

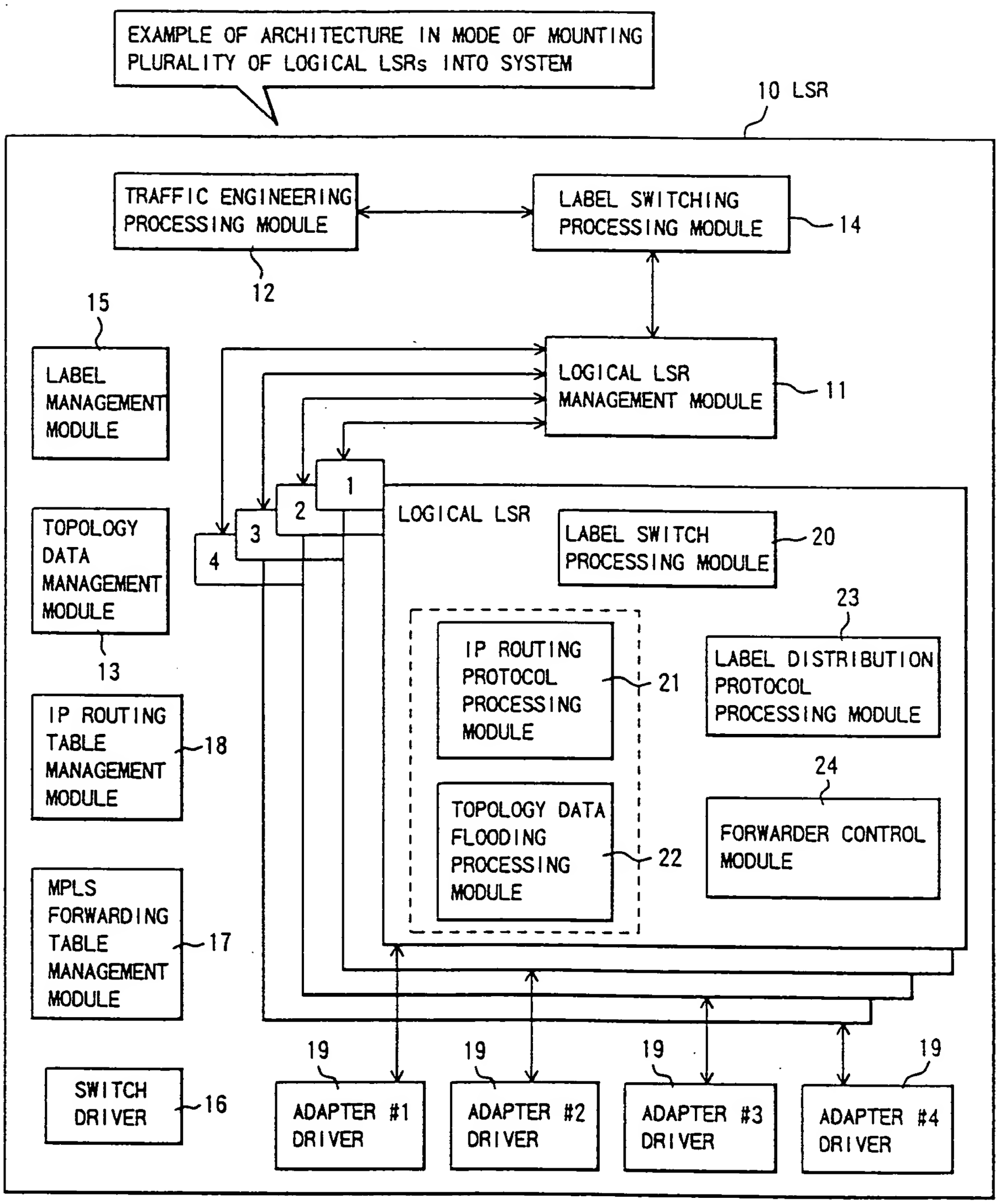
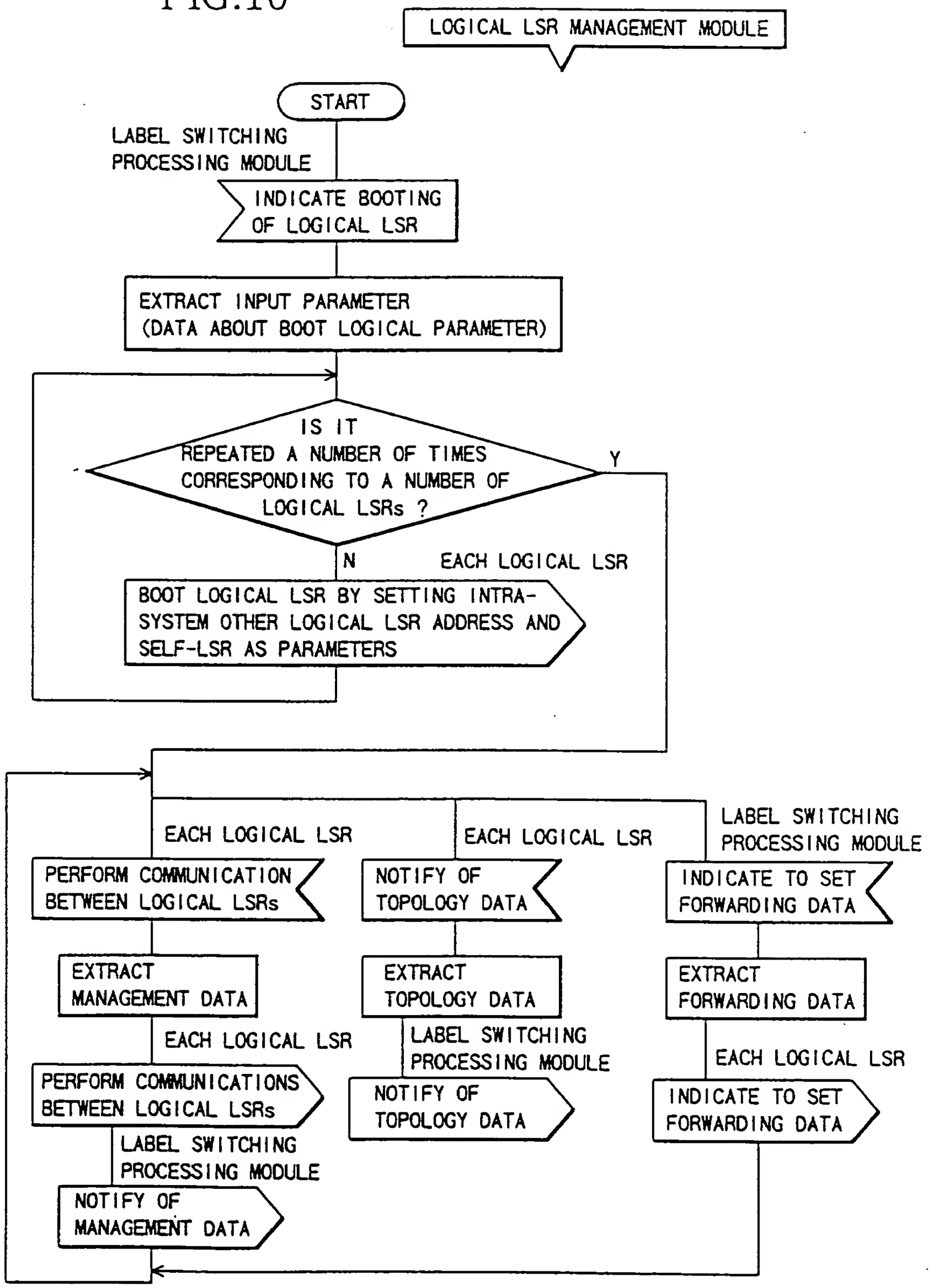

EXAMPLE OF ARCHITECTURE IN MODE OF MOUNTING PLURALITY OF LOGICAL LSRs INTO SYSTEM
10 LSR
TRAFFIC ENGINEERING PROCESSING MODULE
12
LABEL SWITCHING PROCESSING MODULE
14
15
LABEL MANAGEMENT MODULE
LOGICAL LSR MANAGEMENT MODULE
11
1
2
3
4
LOGICAL LSR
TOPOLOGY DATA MANAGEMENT MODULE
13
LABEL SWITCH PROCESSING MODULE
20
23
IP ROUTING PROTOCOL PROCESSING MODULE
21
LABEL DISTRIBUTION PROTOCOL PROCESSING MODULE
IP ROUTING TABLE MANAGEMENT MODULE
18
24
TOPOLOGY DATA FLOODING PROCESSING MODULE
22
FORWARDER CONTROL MODULE
MPLS FORWARDING TABLE MANAGEMENT MODULE
17
SWITCH DRIVER
16
19
ADAPTER #1 DRIVER
ADAPTER #2 DRIVER
ADAPTER #3 DRIVER
ADAPTER #4 DRIVER

FIG.10



0050564 "4050"

FIG.11

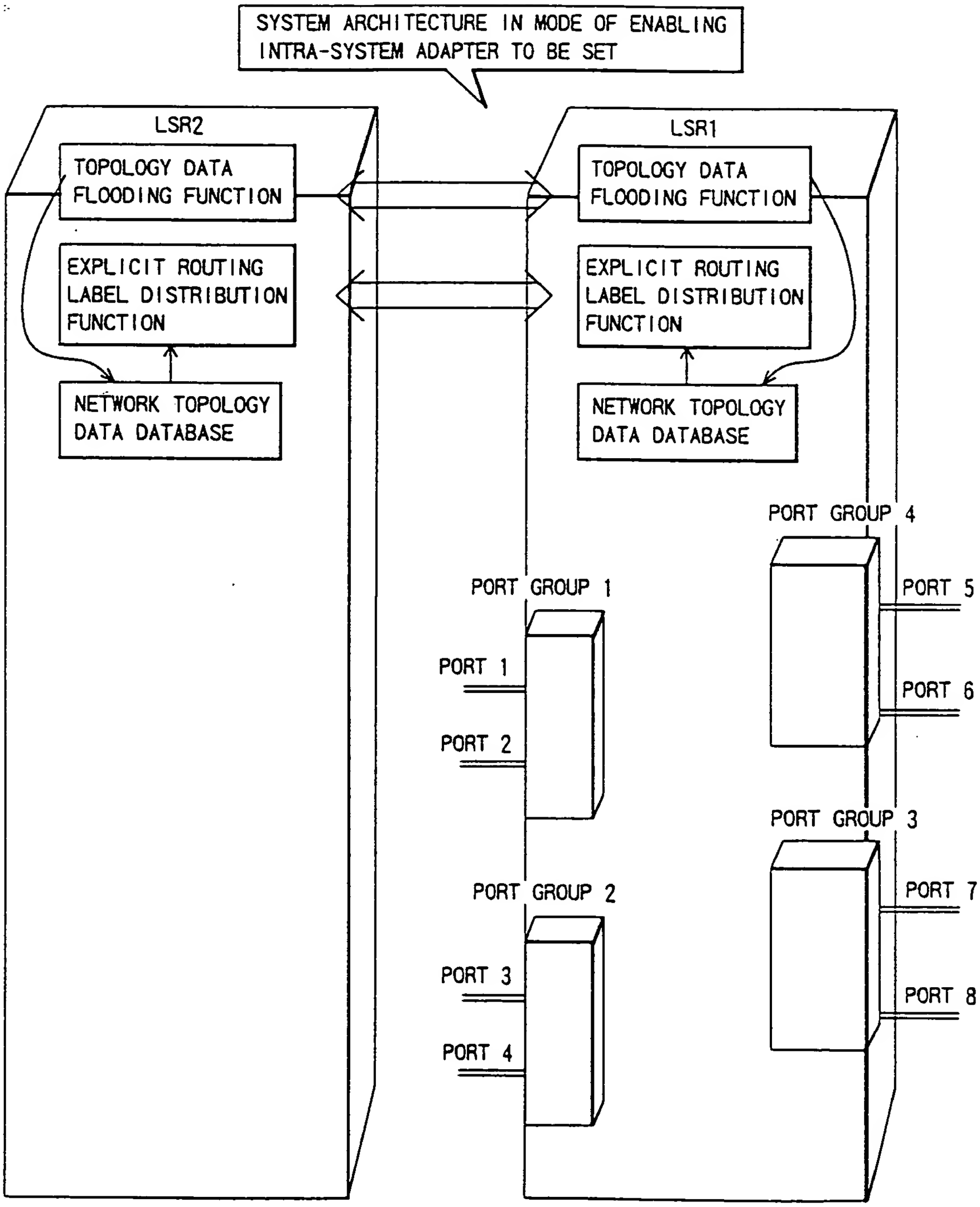

SYSTEM ARCHITECTURE IN MODE OF ENABLING INTRA-SYSTEM ADAPTER TO BE SET
LSR2
TOPOLOGY DATA FLOODING FUNCTION
EXPLICIT ROUTING LABEL DISTRIBUTION FUNCTION
NETWORK TOPOLOGY DATA DATABASE
LSR1
TOPOLOGY DATA FLOODING FUNCTION
EXPLICIT ROUTING LABEL DISTRIBUTION FUNCTION
NETWORK TOPOLOGY DATA DATABASE
PORT GROUP 1
PORT 1
PORT 2
PORT GROUP 2
PORT 3
PORT 4
PORT GROUP 4
PORT 5
PORT 6
PORT GROUP 3
PORT 7
PORT 8

FIG.12

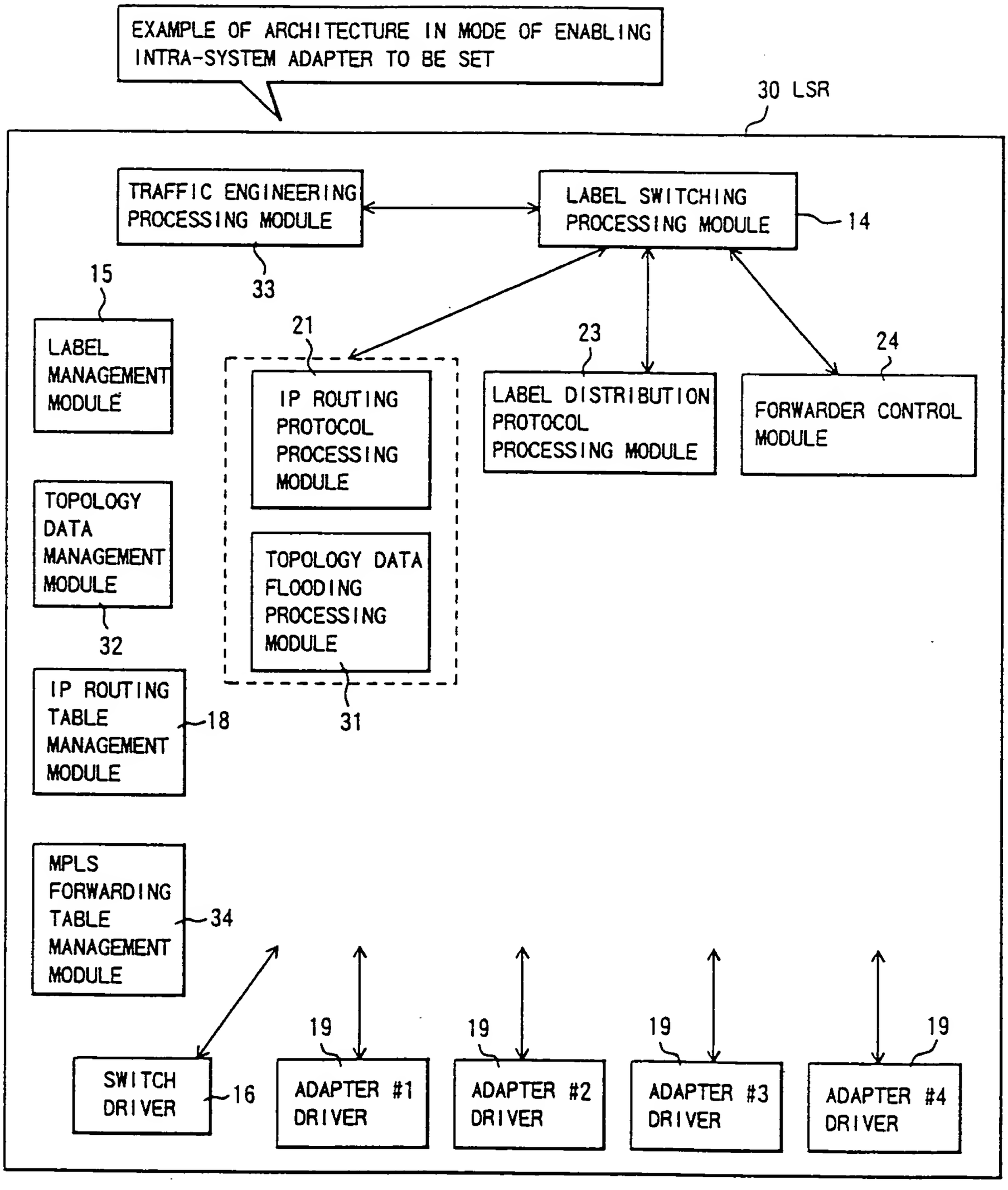
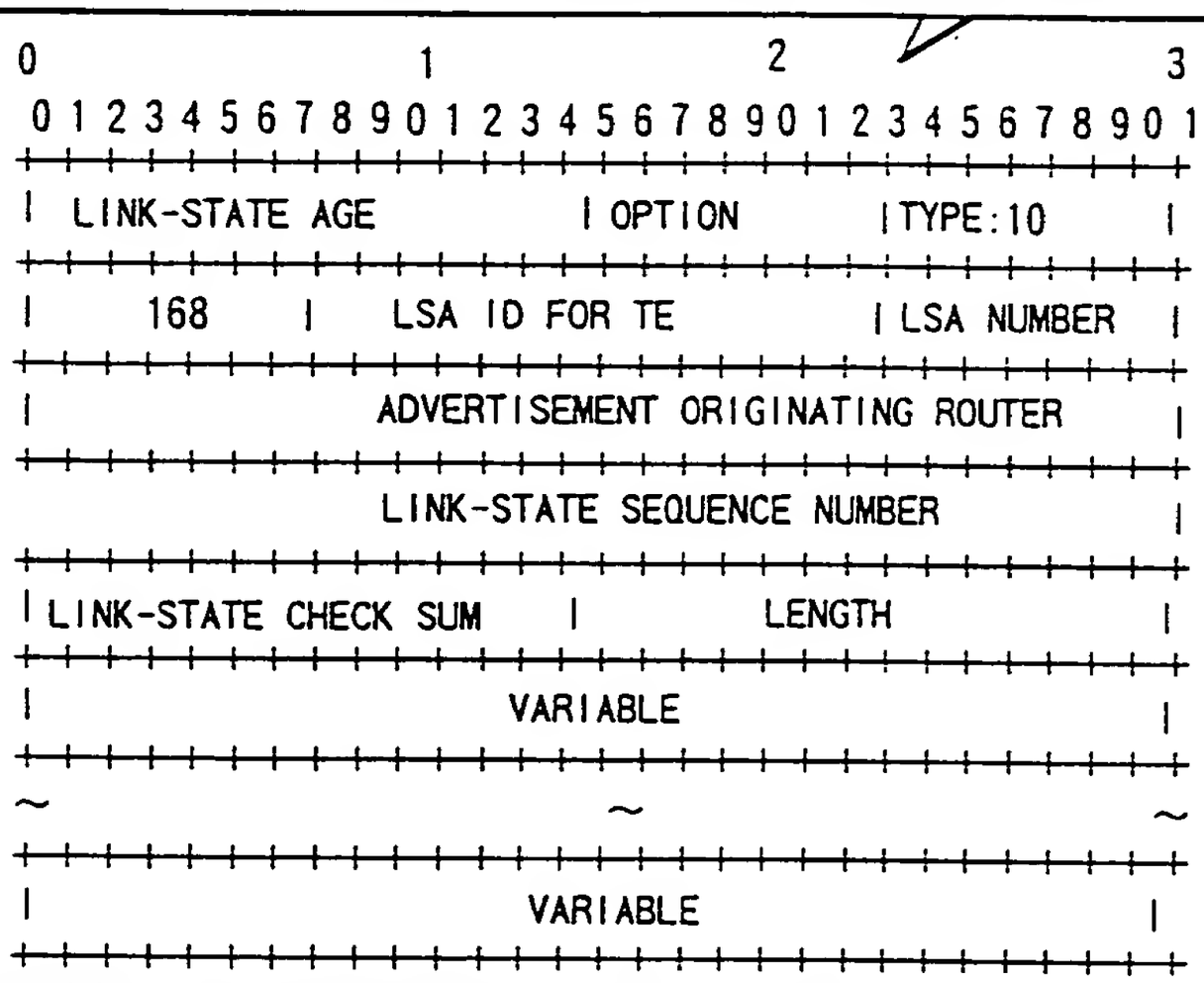

EXAMPLE OF ARCHITECTURE IN MODE OF ENABLING INTRA-SYSTEM ADAPTER TO BE SET
30 LSR
TRAFFIC ENGINEERING PROCESSING MODULE
33
LABEL SWITCHING PROCESSING MODULE
14
15
LABEL MANAGEMENT MODULE
21
IP ROUTING PROTOCOL PROCESSING MODULE
TOPOLOGY DATA FLOODING PROCESSING MODULE
31
23
LABEL DISTRIBUTION PROTOCOL PROCESSING MODULE
24
FORWARDER CONTROL MODULE
TOPOLOGY DATA MANAGEMENT MODULE
32
IP ROUTING TABLE MANAGEMENT MODULE
18
MPLS FORWARDING TABLE MANAGEMENT MODULE
34
SWITCH DRIVER
16
19
ADAPTER #1 DRIVER
ADAPTER #2 DRIVER
ADAPTER #3 DRIVER
ADAPTER #4 DRIVER

FIG.13

EXAMPLE OF DEFINITION OF OPAQUE LSA OF OSPF FOR TRAFFIC ENGINEERING



1:ROUTER ADDRESS TVLV(TYPE-VARIABLE LENGTH-VALUE)
4-OCTET IP ADDRESS OF ROUTER FOR GENERATING LSA

2:NEIGHBOR TVLV
DESCRIBE ADJACENT SERIES IN TRAFFIC ENGINEERING TOPOLOGY
LINK TYPE, LINK ID, METRIC, SUB-TVLVs AND SUB-TVLVs OF SIZE 0 OR LARGER INCLUSIVE. SUB-TVLVs ARE USED FOR SUPPLYING ADDED DATA

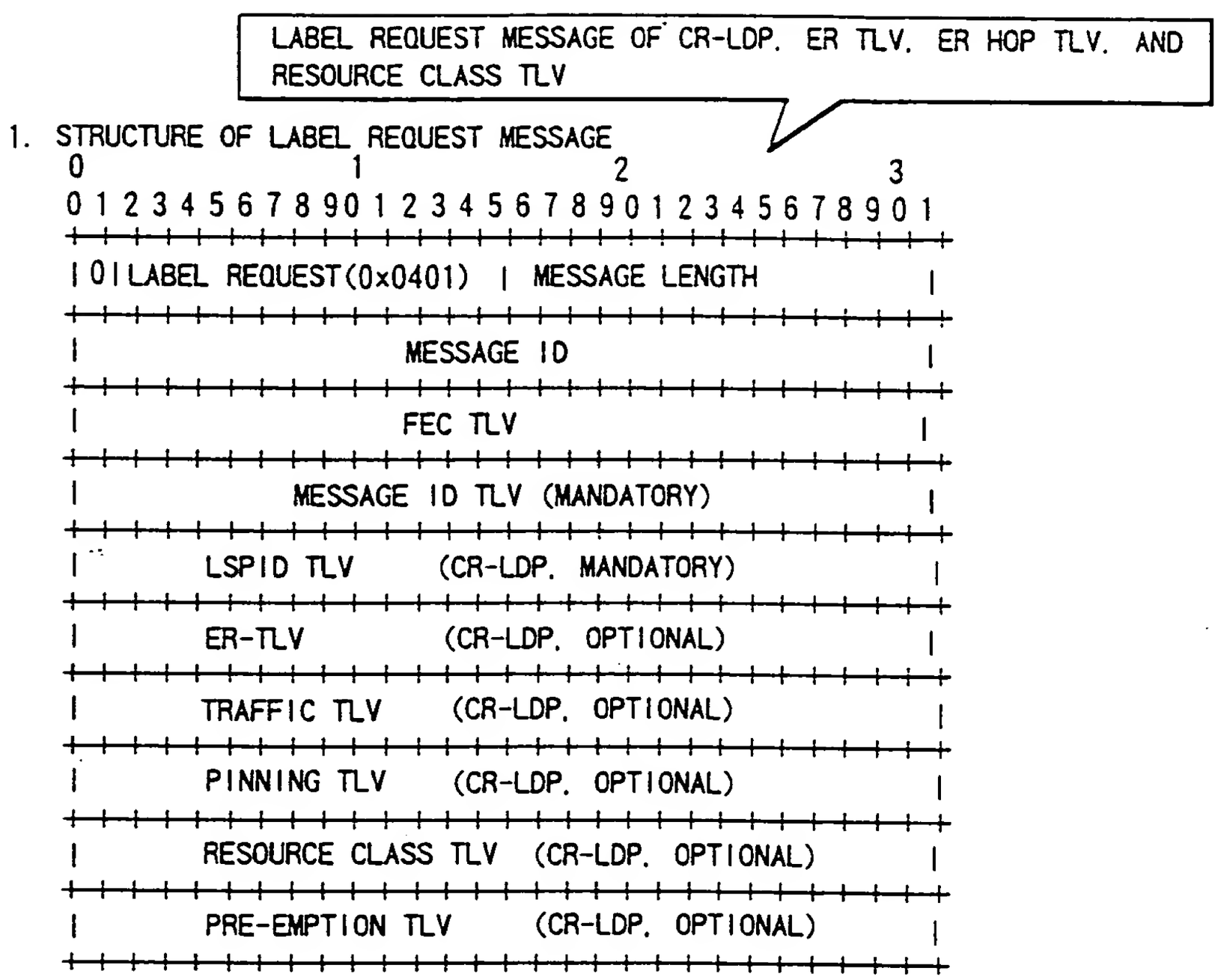
LINK TYPE	1 OCTETS, 1:P2P, 2:MULTI-ACCESS
LINK ID	4 OCTETS
METRIC	4 OCTETS
LENGTH OF SUB-TVLV	2 OCTETS

SUB-TVLVs OF 0-65504 OCTETS, FOLLOWING SUB-TVLVs ARE DEFINED

SUB-TVLV TYPE.	LRNGTH (OCTET).	VALUE (OCTET).	NAME
1	1	4	INTERFACE ADDRESS
2	1	4	ADJACENT ADDRESS
3	1	4	MAXIMUM LINK BAND
4	1	2	MAXIMUM POSSIBLE-OF-ALLOCATION LIUNK BAND(%)
5	1	32	PRESENT RESERVE BAND
6	1	4	RESOURCE CLASS (COLOR, MANAGEMENT GROUP)

* THIS IS 4-OCTET BIT MASK ALLOCATED BY NETWORK MANAGER AND EACH BIT CORRESPONDS TO ONE MANAGEMENT GROUP ALLOCATED TO INTERFACE

FIG.14



2. STRUCTURE OF EXPLICIT ROUTE TLV (ER-TLV)

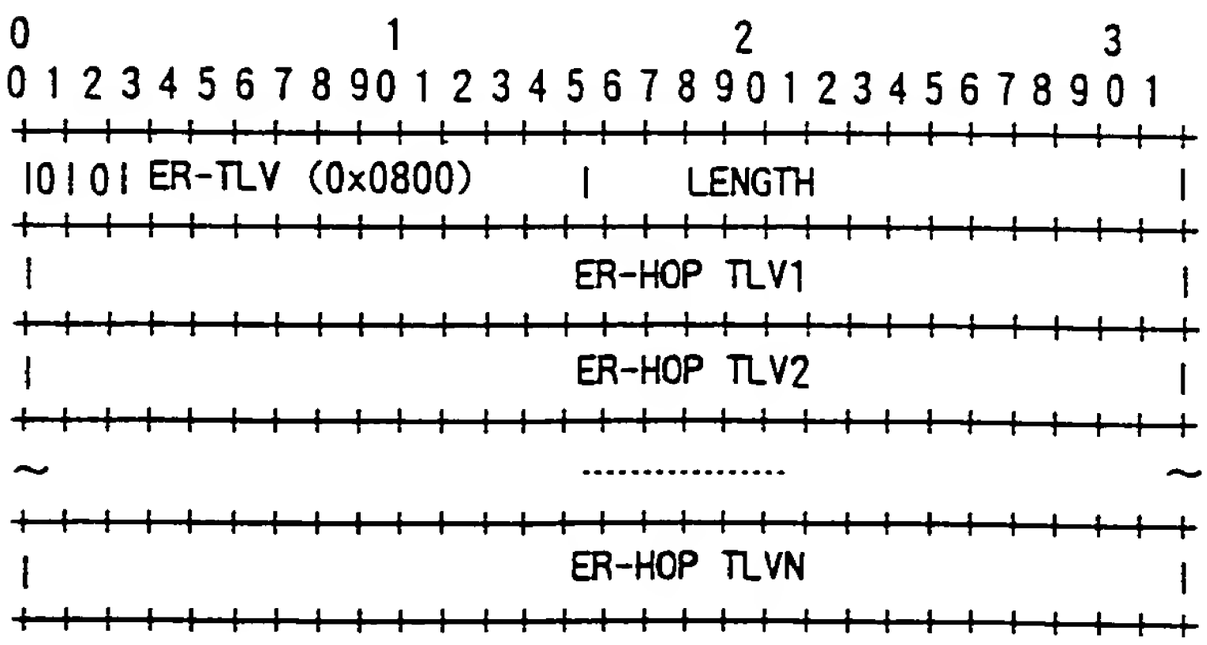
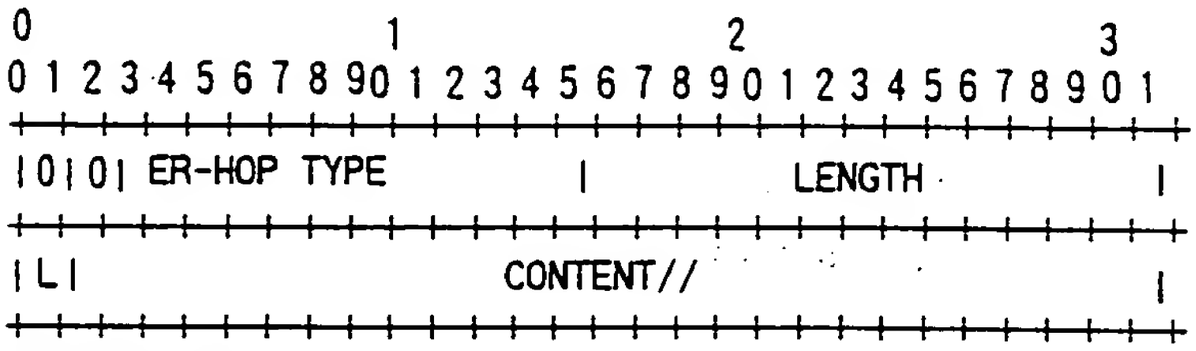


FIG.15

LABEL REQUEST MESSAGE OF CR-LDP. ER TLV. ER HOP TLV. AND RESOURCE CLASS TLV

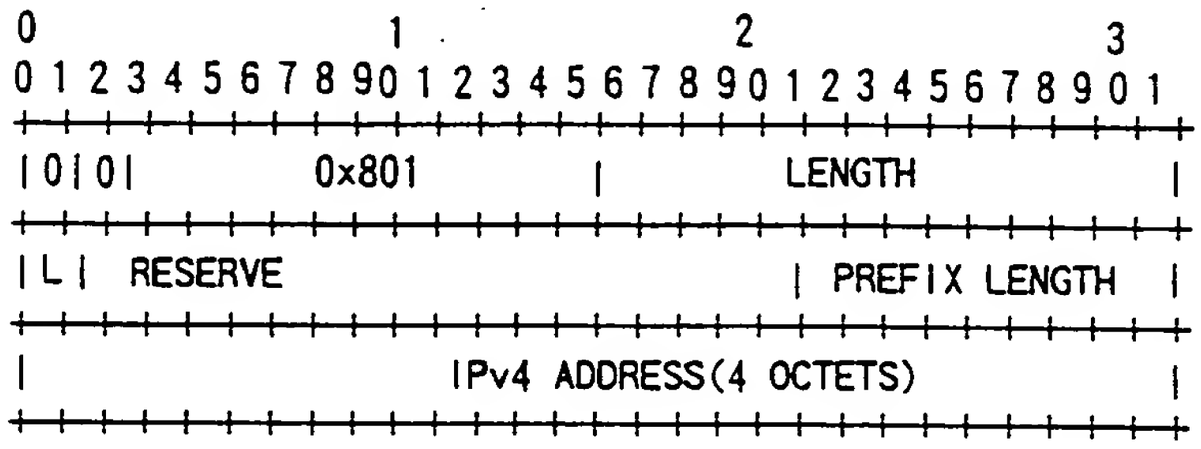
3. STRUCTURE OF EXPLICIT ROUTE HOP TLV(ER-HOP TLV)



ER-HOP TYPE

VALUE	TYPE
0x801	IPv4 PREFIX
0x802	IPv6 PREFIX
0x803	SELF-SUPPORTED SYSTEM NUMBER
0x804	LSPID

4. STRUCTURE OF IPv4 PREFIX



5. STRUCTURE OF RESOURCE CLASS(COLOR) TLV

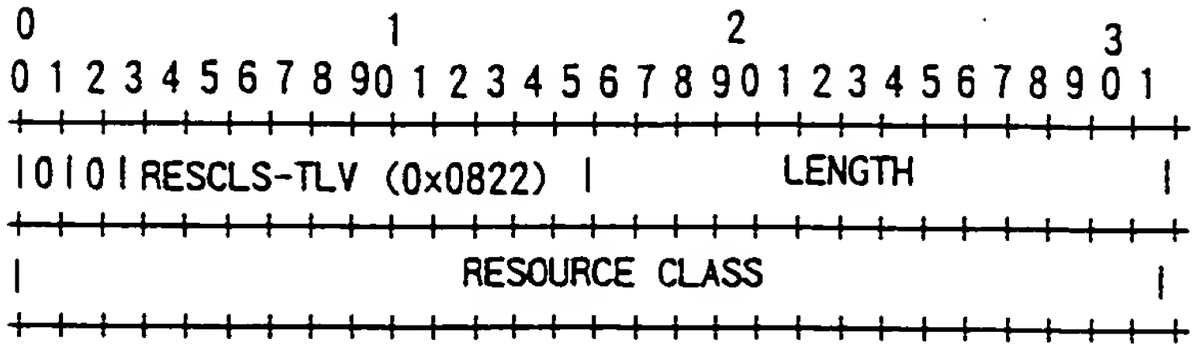
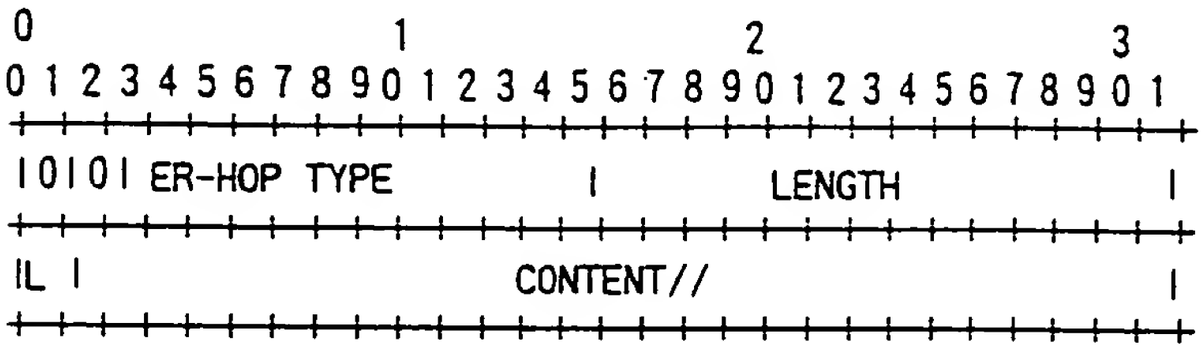


FIG.16

EXAMPLE OF ADDITIONAL DEFINITION OF ER HOP TLV

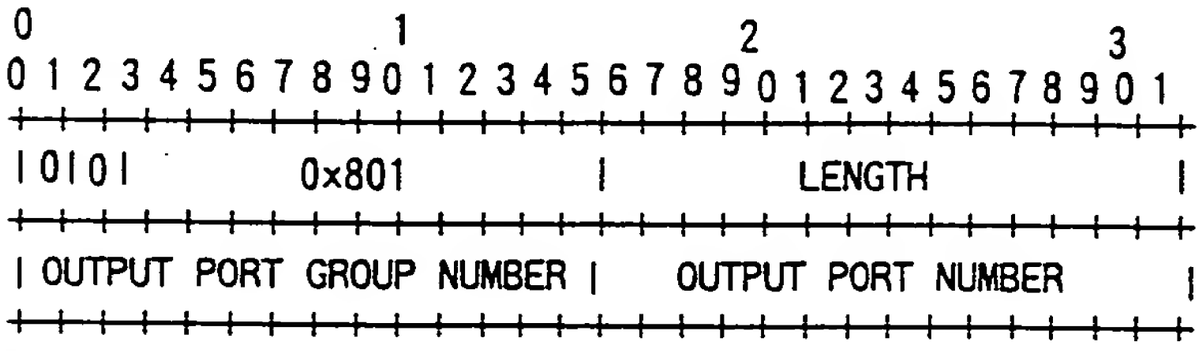
1. EXAMPLE OF STRUCTURE OF EXPLICIT ROUTE HOP TLV (ER-HOP TLV)



ER-HOP TYPE

VALUE	TYPE	
0x801	IPv4 PREFIX	
0x802	IPv6 PREFIX	
0x803	SELF-SUPPORTED SYSTEM NUMBER	
0x804	LSPID	
0x805	PORT AND PORT GROUP (LINK AND LINK GROUP)	← EXAMPLE OF ADDITION
0x806	RESOURCE CLASS	← EXAMPLE OF ADDITION

2. EXAMPLE OF STRUCTURE OF PORT AND PORT GROUP (LINK AND LINK GROUP) ← EXAMPL OF ADDITION



OUTPUT PORT GROUP NUMBER : THIS NUMBER INDICATES PORT GROUP (LINK GROUP OR INTERFACE GROUP) IN DOWNSTREAM DIRECTION OF LSP PASSING THROUGH SYSTEM
ALL'1' INDICATES WILD CARD. THIS CARD IS USED FOR SPECIFYING ONLY OUTPUT PORT

OUTPUT PORT NUMBER : THIS NUMBER INDICATES PORT (LINK OR INTERFACE) IN DOWNSTREAM DIRECITON OF LSP PASSING THROUGH SYSTEM
ALL'1' INDICATES WILD CARD. THIS IS USED FOR SPECIFYING ONLY OUTPUT PORT GROUP

FIG.17

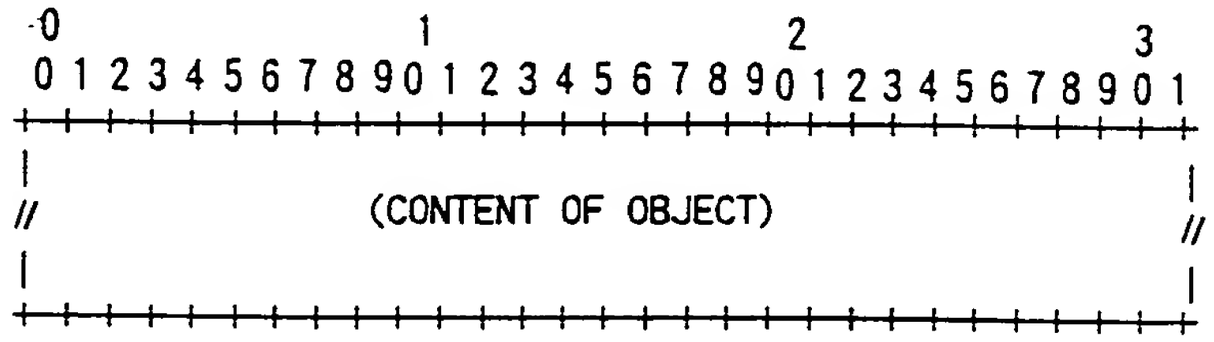
PATH MESSAGE OF RSVP EXTENSION. EXPLICIT_ROUTE OBJECT AND IPv4 SUBOBJECT

1. STRUCTURE OF PATH MESSAGE

<PATH MESSAGE>::= <COMMON HEADER>[<INTEGRITY>]
<SESSION><RSVP_HOP>
<TIME_VALUES>
[<EXPLICIT_ROUTE>]
<LABEL_REQUEST>
[<SESSION _ATTRIBUTE>]
[<POLICY_DATA>…]
[<SENDER DESCRIPTOR>]

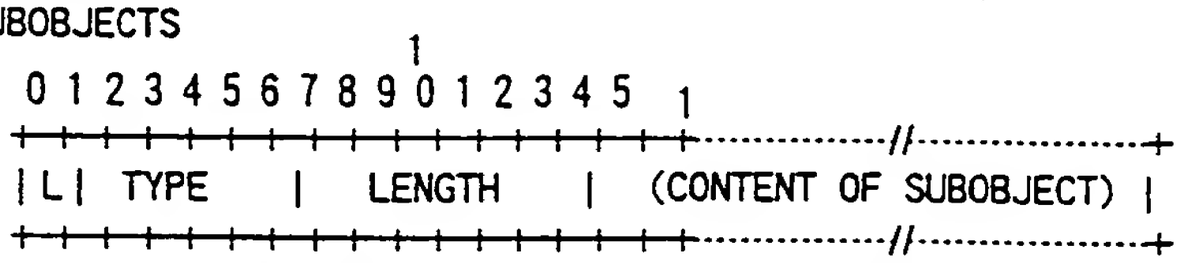
<SENDER DESCRIPTOR>::= <SENDER_TEMPLATE>[<SENDER_TSPEC>]
[<ADSPEC>]
[<RECORD_ROUTE>]

2. STRUCTURE OF EXPLICIT ROUTE OBJECT



EXPLICIT ROUTE OBJECT IS A SERIES OF VARIABLE LENGTH DATA ITEMS CALLED SUBOBJECTS

3. SUBOBJECTS



TYPE: THIS INDICATES TYPE OF CONTENT OF SUBOBJECT. VALUES DEFINED AT PRESENT ARE AS FOLLOWS

0	RESERVE
1	IPv4 PREFIX
2	IPv6 PREFIX
32	SELF-SUPPORTED SYSTEM NUMBER
64	TERMINATING OF MPLS LABEL SWITCHED PATH

4. IPv4 PREFIX

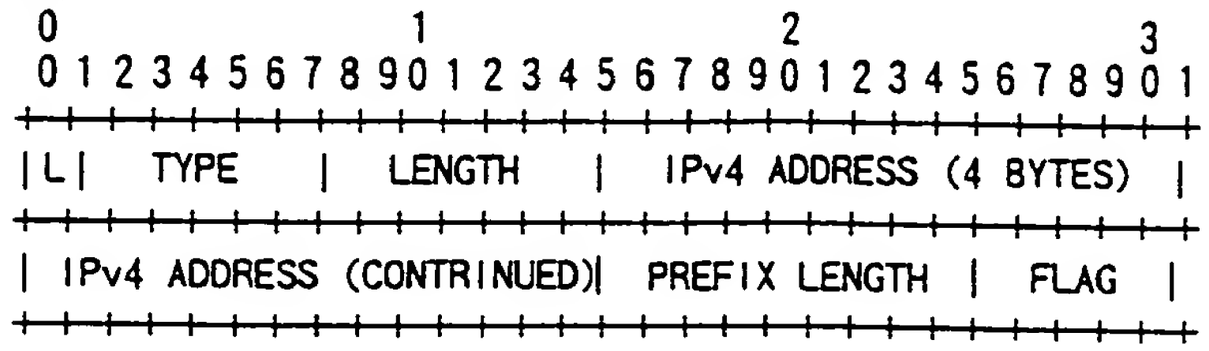
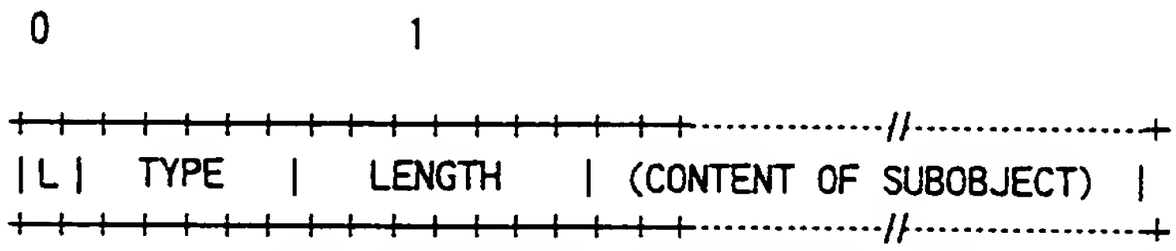


FIG.18

EXAMPLE OF ADDITIONAL DEFINITION OF SUBOBJECT OF EXPLICIT_ROUTE OBJECT

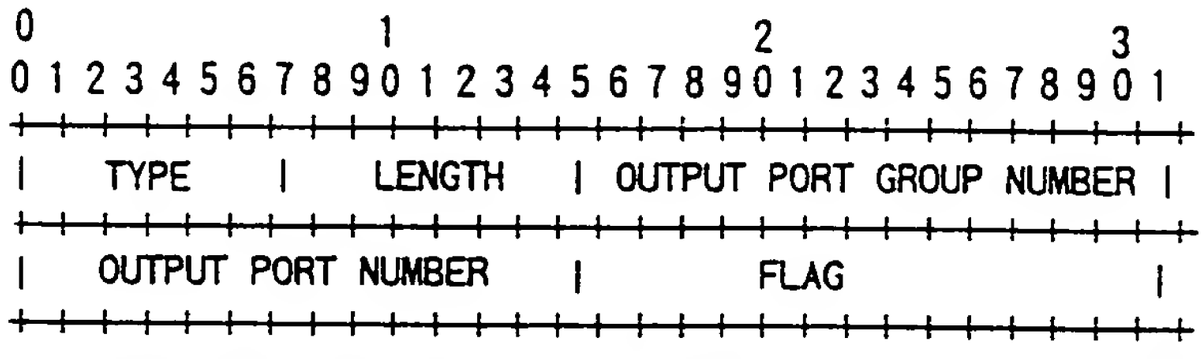
1. SUBOBJECTS



TYPE:THIS INDICATES TYPE OF CONTENT OF SUBOBJECT. VALUES DEFINED AT PRESENT ARE AS FOLLOWS

0	RESERVE
1	IPv4 PREFIX
2	IPv6 PREFIX
32	SELF-SUPPORTED SYSTEM NUMBER
64	TERMINATING OF MPLS LABEL SWITCHED PATH
127	PORT AND PORT GROUP (LINK AND LINK GROUP) ←ADDITION

2. EXAMPLE OF CONFIGURATION OF PORT AND PORT GROUP (LINK AND LINK GROUP) ←ADDITION



OUTPUT PORT GROUP NUMBER : THIS NUMBER INDICATES PORT GROUP (LINK GROUP OR INTERFACE GROUP) IN DOWNSTREAM DIRECTION OF LSP PASSING THROUGH SYSTEM
ALL'1' INDICATES WILD CARD. THIS IS USED FOR SPECIFYING ONLY OUTPUT PORT

OUTPUT PORT NUMBER : THIS NUMBER INDICATES PORT (LINK OR INTERFACE) IN DOWNSTREAM DIRECITON OF LSP PASSING THROUGH SYSTEM
ALL'1' INDICATES WILD CARD. THIS IS USED FOR SPECIFYING ONLY OUTPUT PORT GROUP

FIG.19

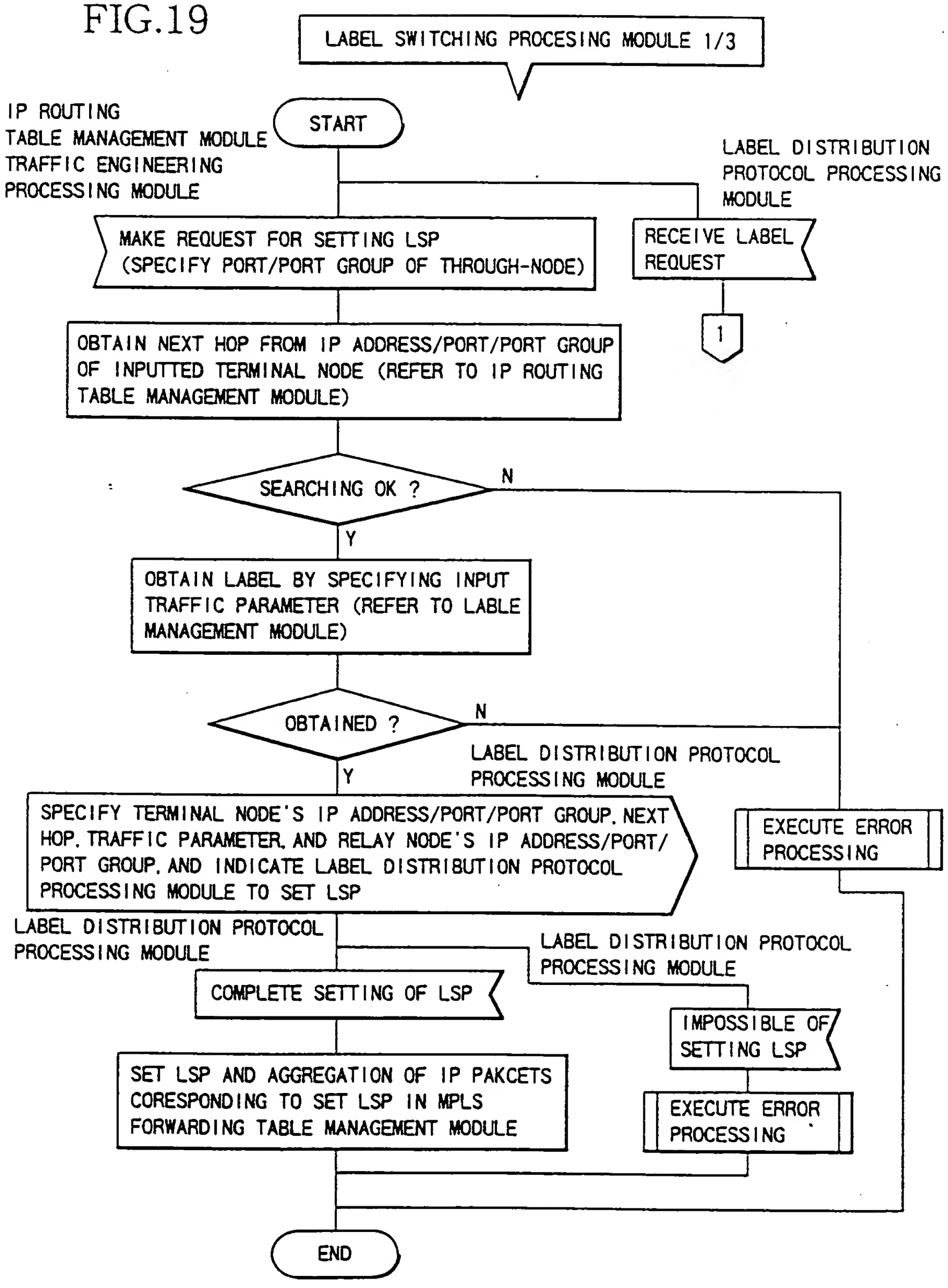
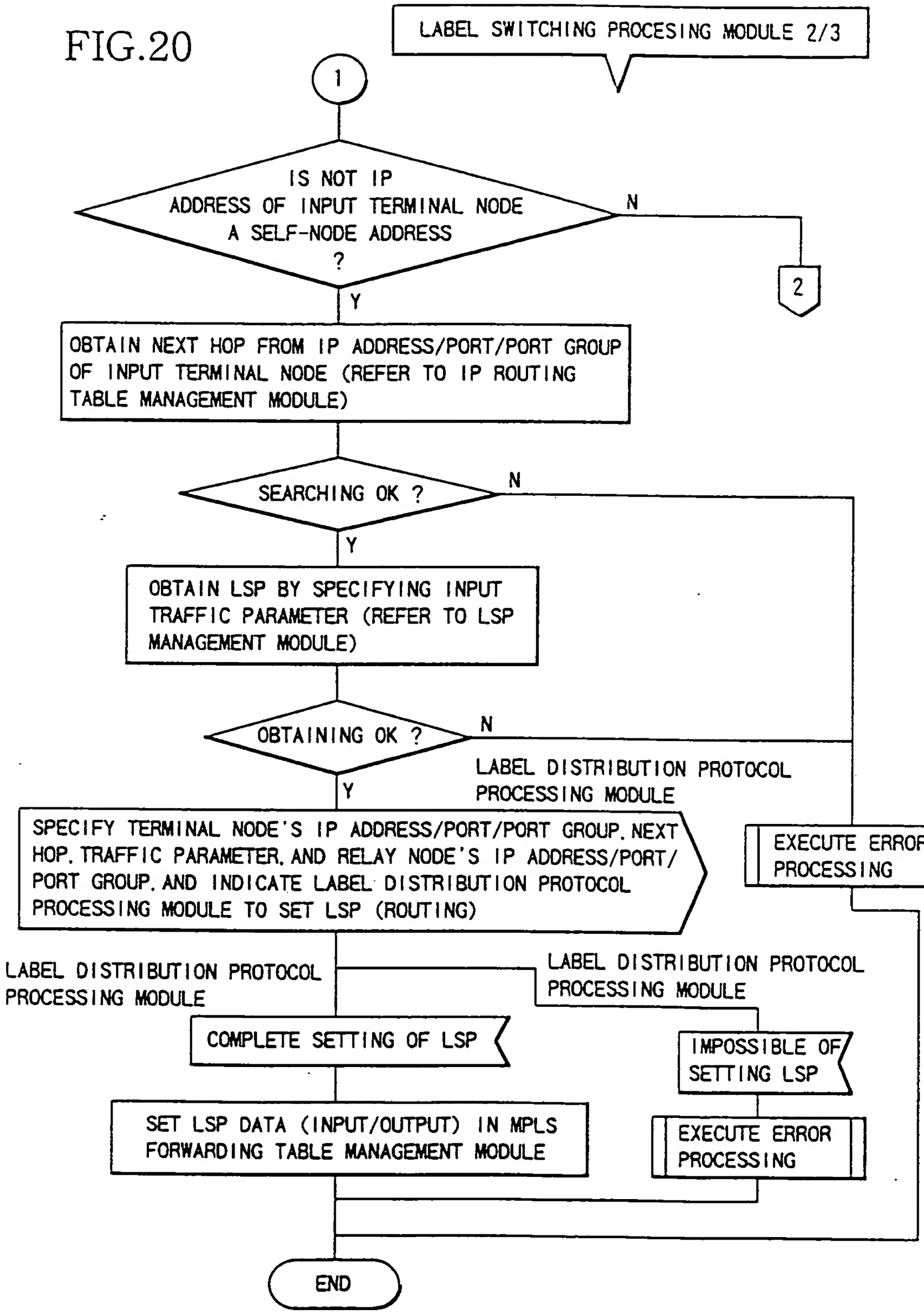

LABEL SWITCHING PROCESING MODULE 1/3
IP ROUTING TABLE MANAGEMENT MODULE TRAFFIC ENGINEERING PROCESSING MODULE
START
LABEL DISTRIBUTION PROTOCOL PROCESSING MODULE
MAKE REQUEST FOR SETTING LSP (SPECIFY PORT/PORT GROUP OF THROUGH-NODE)
RECEIVE LABEL REQUEST
1
OBTAIN NEXT HOP FROM IP ADDRESS/PORT/PORT GROUP OF INPUTTED TERMINAL NODE (REFER TO IP ROUTING TABLE MANAGEMENT MODULE)
SEARCHING OK ?
N
Y
OBTAIN LABEL BY SPECIFYING INPUT TRAFFIC PARAMETER (REFER TO LABLE MANAGEMENT MODULE)
OBTAINED ?
N
Y
LABEL DISTRIBUTION PROTOCOL PROCESSING MODULE
SPECIFY TERMINAL NODE'S IP ADDRESS/PORT/PORT GROUP, NEXT HOP, TRAFFIC PARAMETER, AND RELAY NODE'S IP ADDRESS/PORT/ PORT GROUP, AND INDICATE LABEL DISTRIBUTION PROTOCOL PROCESSING MODULE TO SET LSP
EXECUTE ERROR PROCESSING
LABEL DISTRIBUTION PROTOCOL PROCESSING MODULE
LABEL DISTRIBUTION PROTOCOL PROCESSING MODULE
COMPLETE SETTING OF LSP
IMPOSSIBLE OF SETTING LSP
SET LSP AND AGGREGATION OF IP PAKCETS CORESPONDING TO SET LSP IN MPLS FORWARDING TABLE MANAGEMENT MODULE
EXECUTE ERROR PROCESSING
END

FIG.20



09/06/2004, EAST Version: 1.4.1

FIG.21

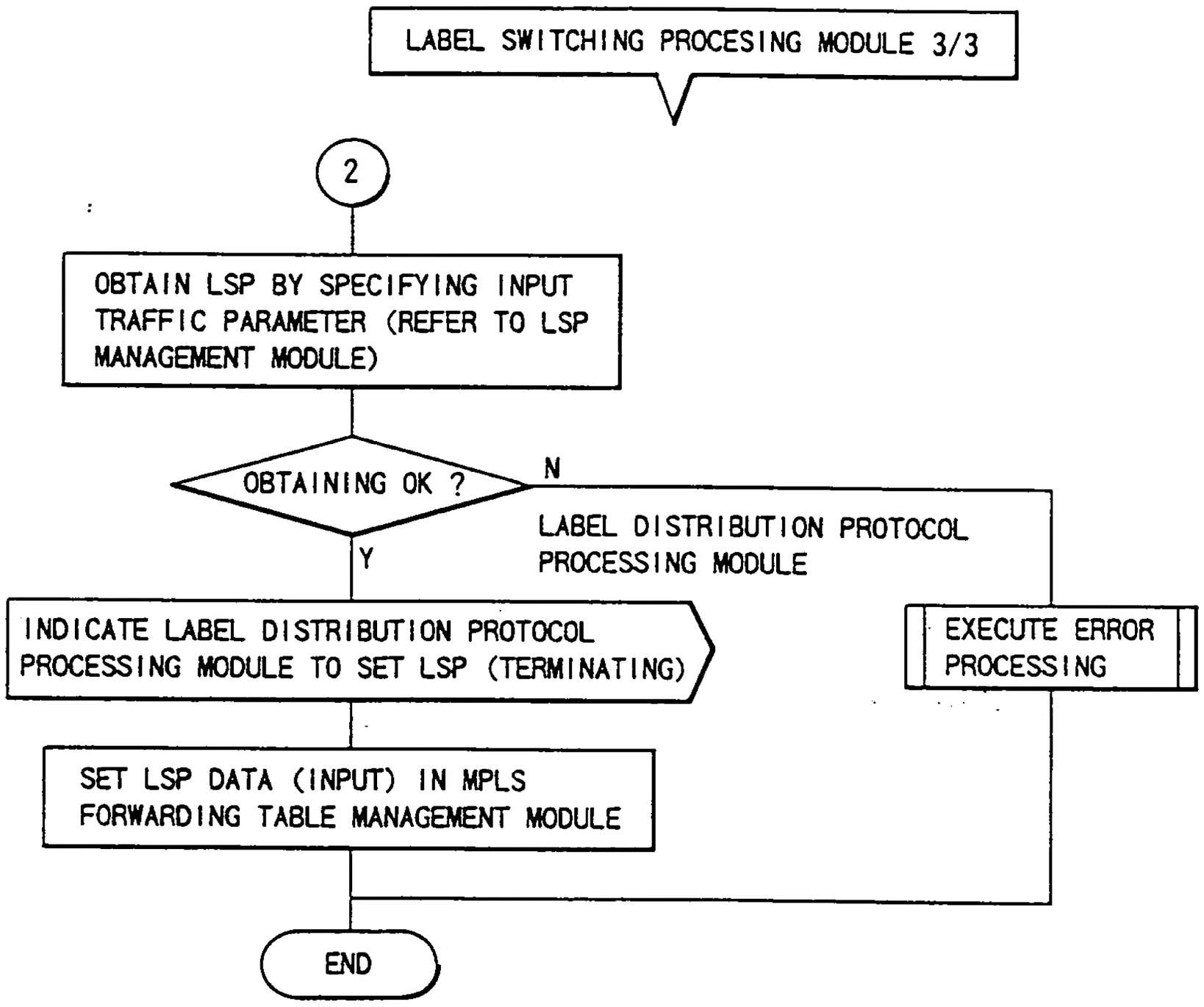

LABEL SWITCHING PROCESING MODULE 3/3
2
OBTAIN LSP BY SPECIFYING INPUT TRAFFIC PARAMETER (REFER TO LSP MANAGEMENT MODULE)
OBTAINING OK ?
N
LABEL DISTRIBUTION PROTOCOL PROCESSING MODULE
Y
INDICATE LABEL DISTRIBUTION PROTOCOL PROCESSING MODULE TO SET LSP (TERMINATING)
EXECUTE ERROR PROCESSING
SET LSP DATA (INPUT) IN MPLS FORWARDING TABLE MANAGEMENT MODULE
END

FIG.22

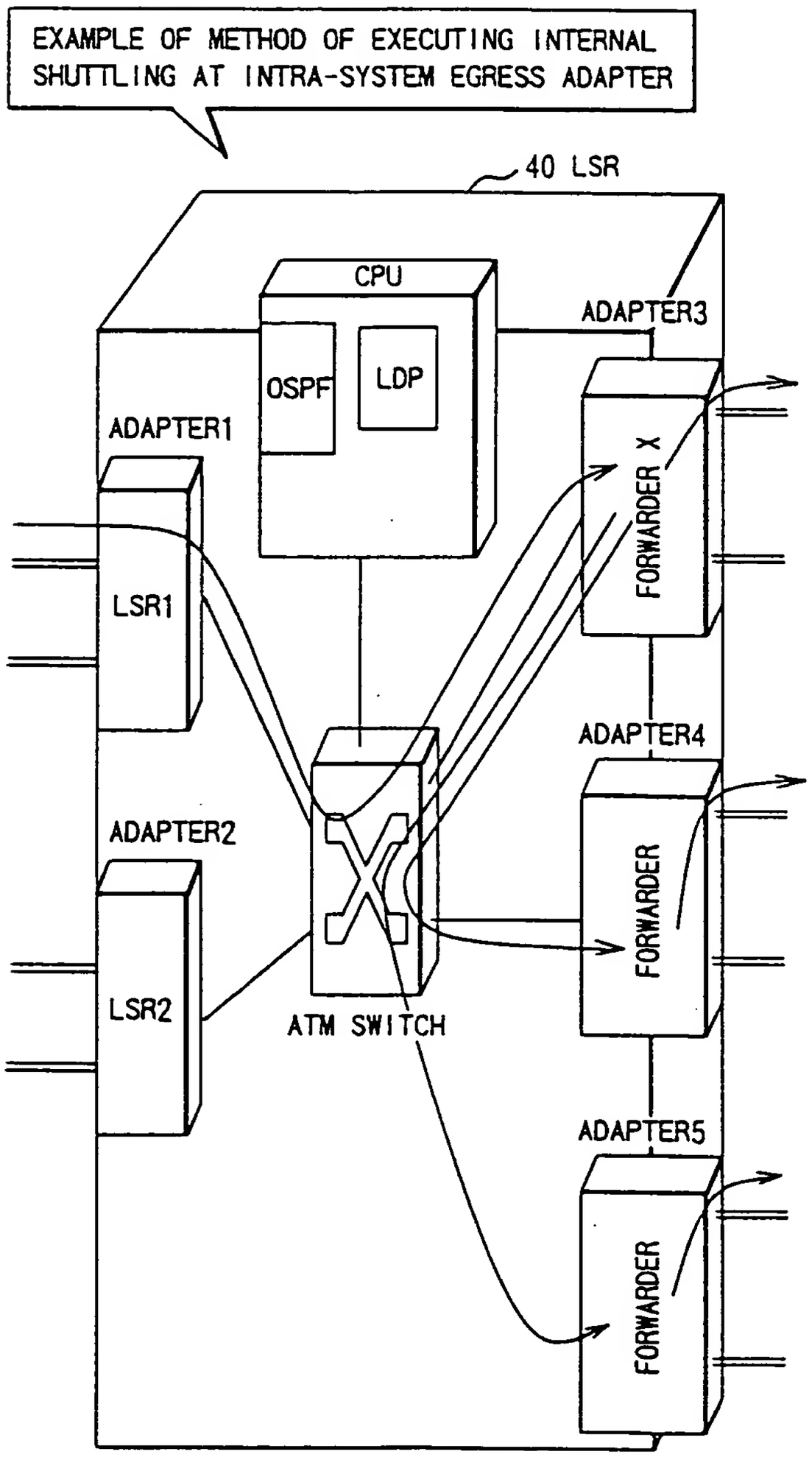
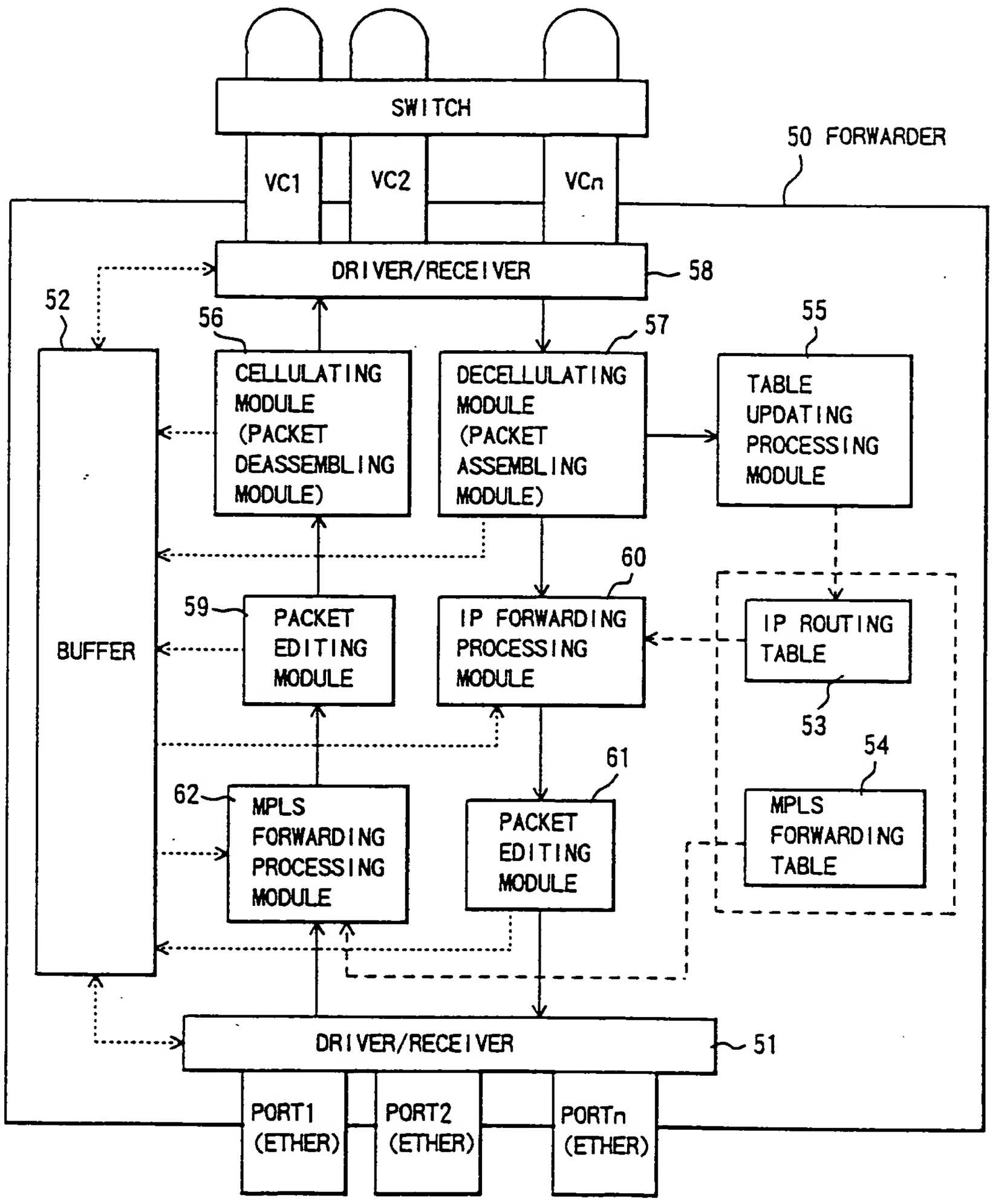

EXAMPLE OF METHOD OF EXECUTING INTERNAL SHUTTLING AT INTRA-SYSTEM EGRESS ADAPTER
40 LSR
CPU
OSPF
LDP
ADAPTER1
ADAPTER2
ADAPTER3
ADAPTER4
ADAPTER5
LSR1
LSR2
ATM SWITCH
FORWARDER X
FORWARDER
FORWARDER
FORWARDER

FIG.23



——————— :CONTROL

..... :REFERRING/EDITING OF DATA

- - - - - - - - :REFERRING/UPDATING OF TABLE

FIG.24

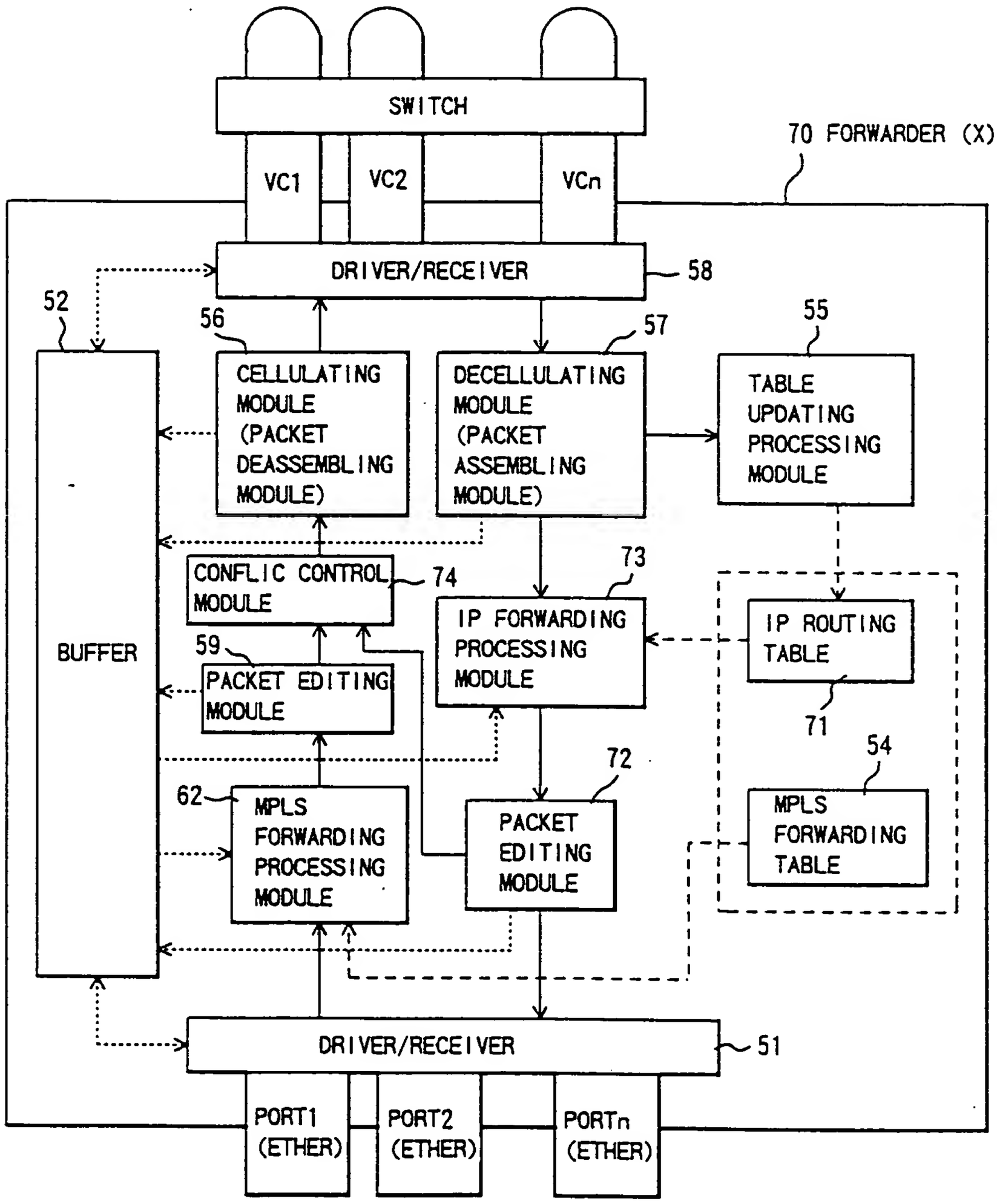
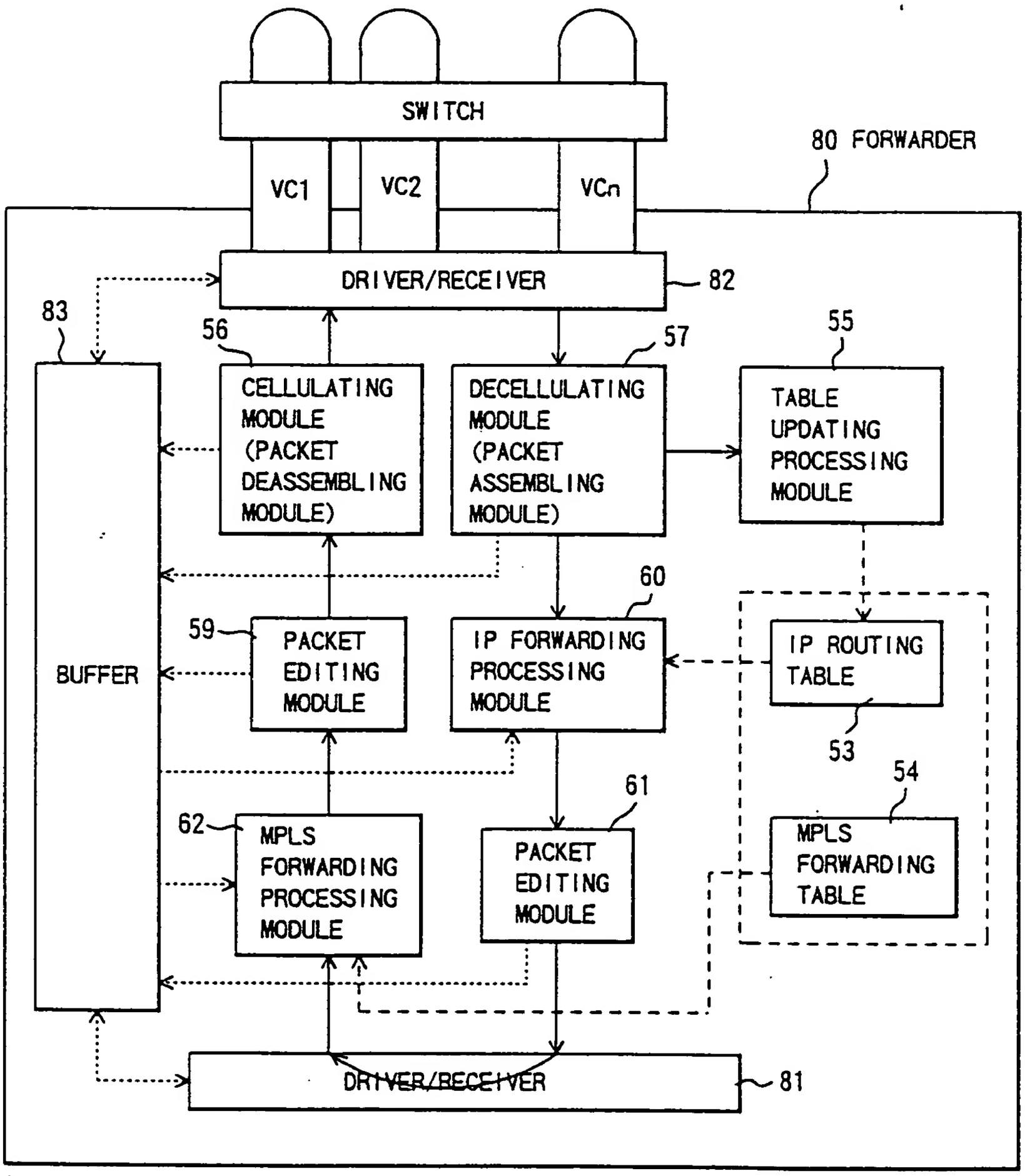

SWITCH
70 FORWARDER (X)
VC1
VC2
VCn
DRIVER/RECEIVER
58
52
56
57
55
CELLULATING MODULE (PACKET DEASSEMBLING MODULE)
DECELLULATING MODULE (PACKET ASSEMBLING MODULE)
TABLE UPDATING PROCESSING MODULE
CONFLIC CONTROL MODULE
74
73
BUFFER
59
PACKET EDITING MODULE
IP FORWARDING PROCESSING MODULE
IP ROUTING TABLE
71
54
72
62
MPLS FORWARDING PROCESSING MODULE
PACKET EDITING MODULE
MPLS FORWARDING TABLE
DRIVER/RECEIVER
51
PORT1 (ETHER)
PORT2 (ETHER)
PORTn (ETHER)
:CONTROL
:REFERRING/EDITING OF DATA
:REFERRING/UPDATING OF TABLE

FIG.25



——————— :CONTROL

..... :REFERRING/EDITING OF DATA

- - - - - - - - :REFERRING/UPDATING OF TABLE